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ANALYSIS OF MISCELLANEOUS HUMAN OSTEOLOGICAL REMAINS RECOVERED FROM MULTI-COUNTY AREAS OF SOUTH DAKOTA

FINAL REPORT

by
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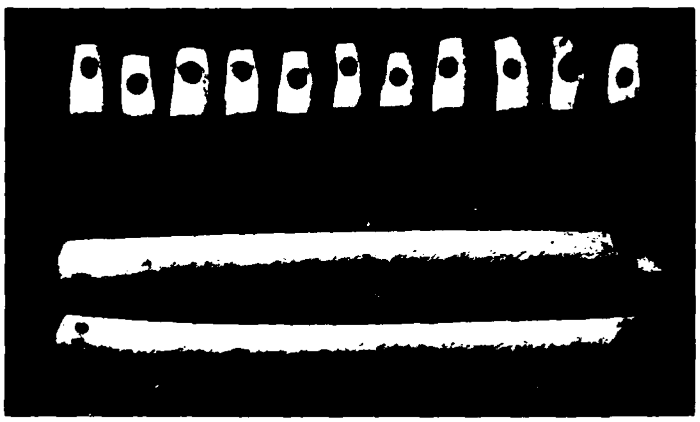
Contribution Number 238



April 1988

Submitted in partial fulfillment of Contract No. DACW45-87-M-0274 Dated 7 May 1987, between the Omaha District Corps of Engineers, U.S. Department of the Army, Omaha, Nebraska, and the Department of Anthropology, University of North Dakota, Grand Forks, North Dakota.

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A minimum of 55 discrete individuals were identified from human skeletal remains recovered from 29 locations along the Missouri River. Eighteen locations were recorded sites. One location, the LeCompte Catholic Cemetery, was a previously relocated historic cemetery. For the seven sites where culture-historic association could be determined, three were placed within the Coalescent tradition, two within the Middle Missouri tradition, and two within the Woodland tradition. Two sites had radiocarbon dates that overlapped two

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Recovered From Multi-County Areas of South Dakota

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1.0 INTRODUCTION

1.1 Project Objectives

This report was prepared in response to the U.S. Army Corps of Engineers Solicitation No. DACW4587T1895. The project was carried out to fulfill three research objectives. The first and most fundamental of these was to document the skeletal biology of the peoples represented by the osteological remains recovered from Federal lands in South Dakota. The second objective was to place these osteological remains, accompanying artifacts and faunal remains, and the sites they represent into the culture-historic framework of the northern Plains. The final objective was to demonstrate the value, both scientific and informational, of analyzing miscellaneous individual human osteological remains. Given the nature and provenience of these osteological remains meeting these objectives was at times a difficult task. Little beyond basic description could be achieved for those sites where preservation was poor and/or where provenience was minimal or lacking.

1.2 Chronology and Provenience

During a three year period from 1983 through 1986 human skeletal remains were recovered from 29 locations along the Missouri River in South Dakota on Federal lands maintained by the U.S. Army Corps of Engineers (Table 1). These locations were initially identified in the Scope-Of-Work (see Appendix A) as Exhibits A through BB and as Catalogue Nos. 1 through 30 (Catalogue No. 24 was omitted). As Table 1 demonstrates, the skeletal remains at 20 of these locations were discovered by non-archaeologists, most of whom were utilizing recreation areas along the Missouri River. In eighteen of the cases the skeletal remains were removed from their in-situ context before Mr. Timothy Nowak, Corps of Engineers South Dakota field archaeologist, could inspect the site. Only nine burials were recovered by controlled excavation. The remains from eight of the nine locations were discovered during archaeological surveys of Corps of Engineers controlled shoreline along the Missouri River. Due to imminent danger of erosion and/or pothunting these remains were salvaged at the time of discovery. As a result, not only is burial mode often undetermined, but in seven cases the exact location of the burial is unknown. One location, the LeCompte Catholic Cemetery (Exhibit Q, Catalogue No. 18), is an historic cemetery which was relocated by the Corps of Engineers prior to its inundation by the waters of Lake Oahe. In addition, two crania (Catalogue No. 26) included with Exhibit X have no provenience but are presumed to have been recovered along the Missouri River.

1.3 Site Locations

Excluding the remains with no provenience, all of the locations lie along the Missouri River (Table 2). These are distributed over 12 of the 14 counties which abut the Missouri River (Figure 1). Walworth County which includes the city of Mobridge is represented by the largest number of burial locations with seven of the twenty-eight. The locations fall into one of three regions of the Missouri River; Lake Oahe (14 locations), Lake Sharpe (2

Table 1. Chronology and provenience of included sites.

Exh.	Cat. No.	Site	Recovery Date	Finder	Recovery Mode	Recovered By
A	1	Red Horse Hawk	8/16/86	T. Haberman[1]	excavation	T Nowak[2]
B	2	Anton Rygh	8/15/85	recreator	collection	T. Nowak
C	3	Sully	unknown	collectors	collection	collectors
D	4	Blue Blanket Recreation Area	4/2/85	recreator	collection	recreator
E	5	Blue Blanket Recreation Area	3/24/84	recreator	collection	park ranger
F	6	Fort Thompson Area	May 1985	recreator	collection	recreator
G	7	Mobridge	10/14/84	resident	collection	recreator
H	8	Howes	8/14/84	T. Petry[3]	excavation	T. Nowak
I	9/10	Blue Blanket Point	5/29/84	recreator	collection	T. Nowak
J	11	Blue Blanket Point	8/17/83	T. Nowak	collection	T. Nowak
K	12	Pike Haven Recreation Area	1986	resident	collection	resident
L	13	Donahue	7/18/85	T. Nowak	collection	T. Nowak
M	14	Brush Creek Area	1986	resident	collection	park ranger
N	15	Elm Creek Recreation Area	1986	Corps rangers	collection	Corps rangers
O	16	Blue Blanket Point	8/17/83	T. Nowak	collection	T. Nowak
P	17	Okobojo Recreation Area	Spring 1983	recreator	collection	recreator
Q	18	LeCompte Catholic Cemetery	6/21/86	recreator	collection	recreator
R	19	Prairie Dog Bay	4/3/83	recreator	collection	recreator

Table 1. Continued.

Exh.	Cat. No.	Site	Recovery Date	Finder	Recovery Mode	Recovered By
S	20a	39LM59	7/20/83	R. Winham[4]	excavation	R. Winham
T	20b	Fort Lookout II	7/20/83	R. Winham	excavation	R. Winham
U	21	Scalp Creek Cemetery	7/24/83	W. Lees[5]	excavation	W. Lees
V	22	39LM256	7/20/83	R. Winham	excavation	R. Winham
W	23	39ST126	7/11/83	D. Toom[6]	excavation	D. Toom
X	25	39BR13	1986	park ranger	collection	park ranger
X	26	none	unknown	unknown	collection	unknown
Y	27	Sunrise Hill	7/24/85	recreator	collection	T. Nowak
Z	28	Walth Bay	1986	recreator	collection	recreator
AA	29	Platte Creek Recreation Area	5/20/85	resident	collection	resident
BB	30	Brule Flat Village	1986	park ranger	collection	park ranger

[1] South Dakota Department of Transportation archaeologist

[2] Corps of Engineers South Dakota field archaeologist

[3] South Dakota Department of Game, Fish, and Parks

[4] Center for Western Studies, Augustana College

[5] Museum of Anthropology, University of Kansas

[6] Department of Anthropology and Archaeology, University of North Dakota

Table 2. Site locations.

Exhibit	Cat. No.	Site	Site #	County	River Area
A	1	Red Horse Hawk	39CO34	Corson	Lake Oahe
B	2	Anton Rygh	39CA4	Campbell	Lake Oahe
C	3	Sully	39SL4	Sully	Lake Oahe
D	4	Blue Blanket Recreation Area	none	Walworth	Lake Oahe
E	5	Blue Blanket Recreation Area	none	Walworth	Lake Oahe
F	6	Fort Thompson Area	none	Buffalo	Lake Francis Case
G	7	Mobridge	39WW1	Walworth	Lake Oahe
H	8	Howes	39HU203	Hughes	Lake Sharpe
I	9/10	Blue Blanket Point	39WW98	Walworth	Lake Oahe
J	11	Blue Blanket Point	39WW98	Walworth	Lake Oahe
K	12	Pike Haven Recreation Area	none	Sully	Lake Oahe
L	13	Donahue	39LM27	Lyman	Lake Francis Case
M	14	Brush Creek Area	none	Stanley	Lake Oahe
N	15	Elm Creek Recreation Area	none	Brule	Lake Francis Case
O	16	Blue Blanket Point	39WW98	Walworth	Lake Oahe
P	17	Okobojo Recreation Area	none	Sully	Lake Oahe
Q	18	LeCompte Catholic Cemetery	none	Dewey	Lake Oahe
R	19	Prairie Dog Bay	none	Charles Mix	Lake Francis Case

Table 2. Continued.

Exhibit	Cat. No.	Site	Site #	County	River Area
S	20a	none	39LM59	Lyman	Lake Francis Case
T	20b	Fort Lookout II	39LM57	Lyman	Lake Francis Case
U	21	Scalp Creek Cemetery	39GR32	Gregory	Lake Francis Case
V	22	none	39LM256	Lyman	Lake Francis Case
W	23	none	39ST126	Stanley	Lake Sharpe
X	25	none	39BR13	Brule	Lake Francis Case
X	26	none	unknown	unknown	unknown
Y	27	Sunrise Hill	39CH210	Charles Mix	Lake Francis Case
Z	28	Walth Bay	39WW203	Walworth	Lake Oahe
AA	29	Platte Creek Recreation Area	none	Charles Mix	Lake Francis Case
BB	30	Brule Flat Village	39BR10	Brule	Lake Francis Case

locations), and Lake Francis Case (12 locations). Eighteen of the locations involve recorded sites. Several of these, like the Mobridge site (39WW1) (Exhibit G, Catalogue No. 7), have long documented archaeological histories of two or more decades. Other sites like Blue Blanket Point (39WW98) (Exhibits I, J, and O, Catalogue Nos. 9/10, 11, and 16) were recorded as a direct result of the discovery of human skeletal remains at that location.

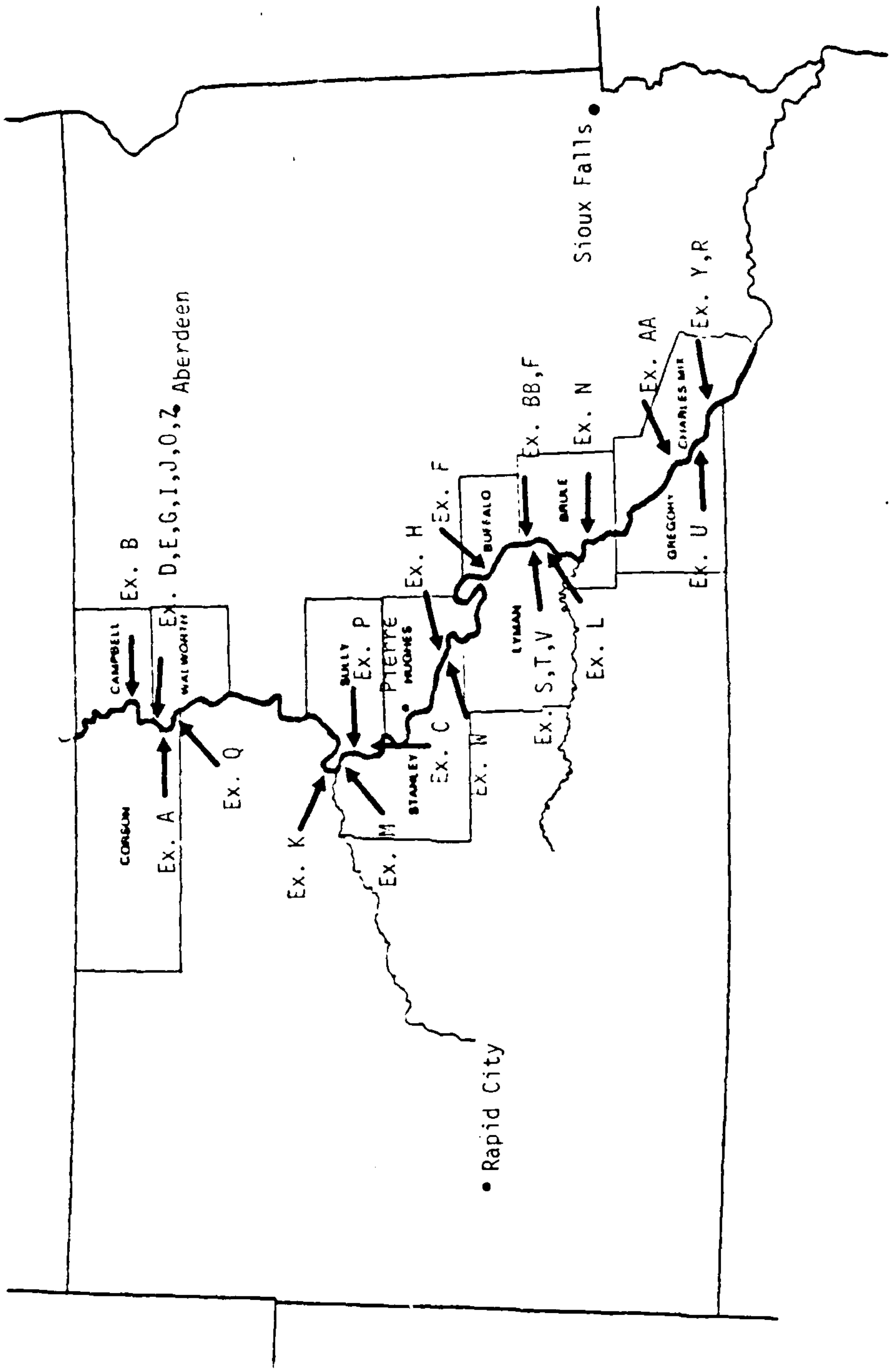


Figure 1. Map of South Dakota showing general site locations by exhibit

2.0 BACKGROUND

2.1 Archaeological Framework

Following Wedel (1961) and Lehmer (1971) the Plains area can be divided into five spatial subareas: the Central Plains, the Northwestern Plains, the Southern Plains, the Middle Missouri, and the Northeastern Plains (Anfinson 1982, Schneider 1982). The sites included in this study are all from the Middle Missouri subarea which can be roughly defined as the trench of the Missouri River in North and South Dakota. Lehmer and Caldwell (1966) subdivide the Middle Missouri Subarea into six regions. From north to south these are the Garrison, Knife-Heart, Cannonball, Grand-Moreau, Bad-Cheyenne, and Big Bend. Each of the southern three regions (Figure 2) is represented by at least one of the sites.

The prehistory of the Middle Missouri (and Northeastern Plains) begins approximately 11,500 years ago with the PALEOINDIAN TRADITION (Table 3). Little is known about these peoples in the northern Plains (senso lato) except that they were for the most part specialized hunters of large game such as the mammoth and extinct forms of bison. What little is known comes primarily from surface finds of tools, projectile points such as those of the Clovis, Folsom, and Plano complexes (Gregg 1985). Several Paleoindian period sites are known from the Middle Missouri Subarea, for example Moe (32MN101) (Schneider 1975), Walth Bay (39WW203) (Ahler et al. 1974), and Travis II (39WW15) (Ahler et al. 1977), but none have been extensively studied. No human skeletal remains from this region have to date been associated with this temporal stage.

Following at approximately 6000 B.C. is the ARCHAIC TRADITION. The Archaic peoples were also hunters, hunters of smaller animals including the modern forms of bison (Lehmer 1971). Included in the technology of the Archaic peoples are notched projectile points such as those of the McKean complex, and ground stone tools such as axes and grinding basins (Gregg 1985; Lass 1981). It is during the Archaic too, that the first evidence of human skeletal remains appears. Among the oldest known human skeletons from the northern Plains are those of the Late Archaic Pipestem Creek site (32SN102) near Jamestown, North Dakota (1591 B.C.) (Fox and Williams 1982) and from the Medicine Crow site (39BF2) near Fort Thompson, South Dakota (5000-2000 B.C.) (Bass 1976).

Moving closer to the present our knowledge of northern Plains prehistory increases. At approximately 500 B.C. the WOODLAND TRADITION is encountered. The Woodland is a period characterized by the first use of pottery and burial mound constructions. The Woodland peoples may have become more sedentary, possibly as a consequence of experimentation with cultivation. This is evidenced in part by their elaborate burial mounds (an eastern influence) and trade (Wedel 1961). A possible transition to horticulture was not rapid, however, and bison hunting continued to play a central part in the subsistence base. Cultivated plants appeared very late on the northern Plains (Schneider 1982). Johnson and Wood (1980) go so far as to characterize the northern Plains Woodland as the Plains Archaic with pottery and burial ceremonialism. This is supported by Woodland skeletal remains which differ significantly from their eastern counterparts with respect to overall health patterns (Lallo and

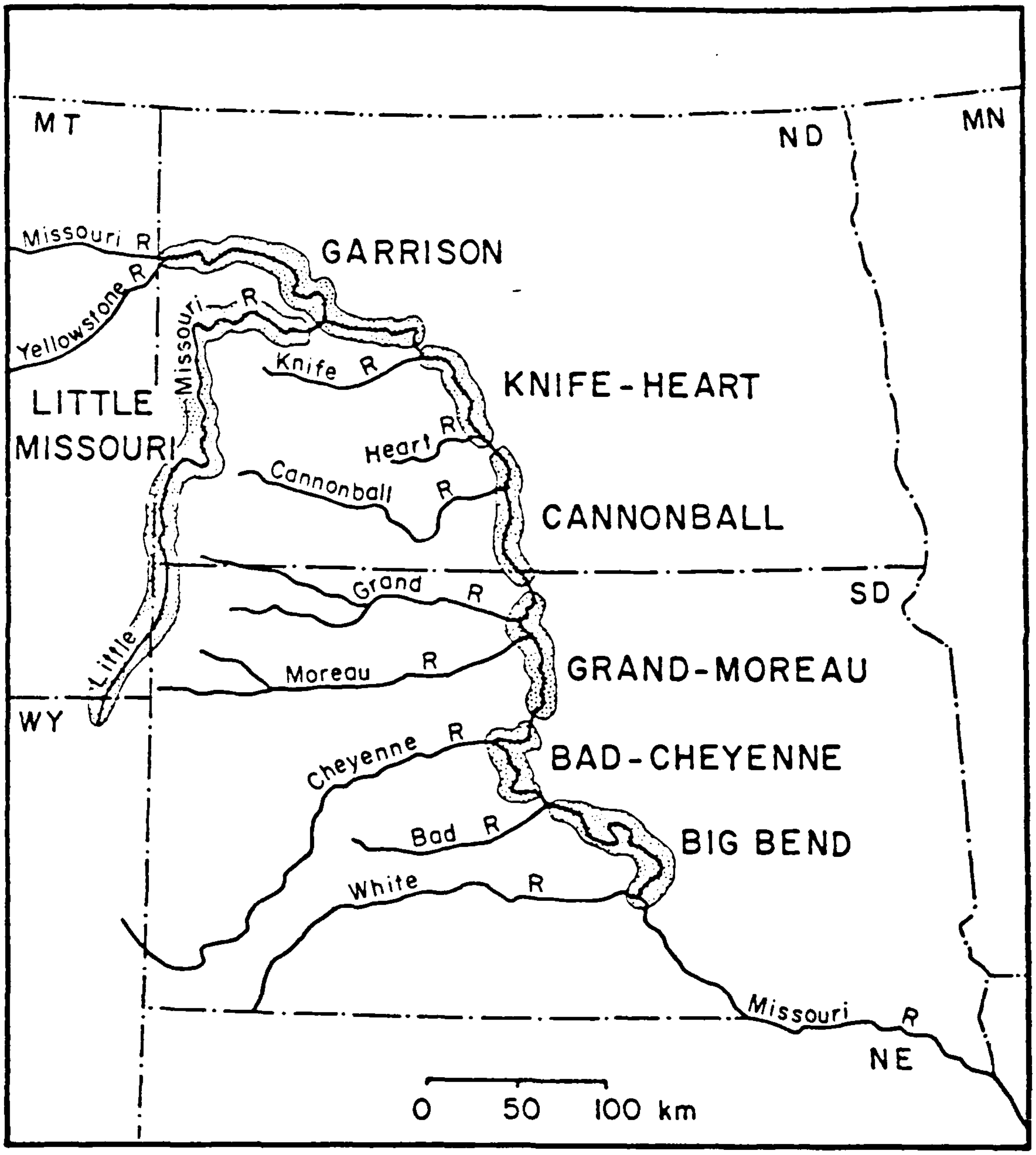


Figure 2. Regions of the Middle Missouri Plains subarea from Lehmer (1971) and Gregg (1985).

Table 3. Chronology of the Middle Missouri Subarea.

Cultural Trad.	Taxonomic Subdivision	Temporal Range	Representative Skeletal Samples
Paleoindian	Clovis Folsom Plano	9,500 - 6,000 B.C.	none
Archaic	Undetermined	6,000 - 500 B.C.	Pipestem Creek (32SN102) (Fox and Williams 1982) Medicine Crow (39BF2) (Bass 1976)
Woodland	Sonota	500 B.C. - A.D. 900	Swift Bird (39DW233), Grover Hand (39DW240), Arpan (39DW252) (Bass and Phenice 1975), Jamestown Mounds (Williams 1985a)
Village	Initial Middle Missouri	A.D. 900 - 1400	Fay Tolton (Bass and Berryman 1976)
	Extended Middle Missouri	A.D. 1000 - 1550	none
	Terminal Middle Missouri	A.D. 1550 - 1675	Huff (32MO11)(Bass and Birkby 1962)
	Initial Coalescent	A.D. 1400 - 1550	Crow Creek (39BF11) (Willey 1982)
	Extended Coalescent	A.D. 1550 - 1675	Anton Rygh (39CA4) (Bass 1983), Mobridge (39WW1) (Jantz 1972)
	Post-Contact Coalescent	A.D. 1675 - 1780	Larson (39WW2) (Jantz 1972), Anton Rygh (39CA4) (Bass 1983), Mobridge (39WW1) (Jantz 1972)
	Disorganized Coalescent	A.D. 1780 -1862	Leavenworth (39CO9) (Bass et al. 1971)

Rose 1979; Lallo et al. 1977; Mensforth et al. 1978; Williams 1982a, 1985a, 1985c). With the elaborate burial mounds of the Woodland come larger and more numerous burial samples. Those of the Sonota complex are prominent in the Middle Missouri. Sonota complex cemeteries include three sites in Dewey County, South Dakota, Swift Bird (39DW233), Grover Hand (39DW240), and Arpan (39DW252) (Bass and Phenice 1975; Neuman 1975), and the Jamestown Mounds (32SN22) in Stutsman County, North Dakota (Snortland-Coles n.d.; Williams 1985a). To the east, along the Red River Valley of North and South Dakota, it is the Arvilla complex and its two major cemeteries, the Arvilla site (32GF1) and the De Spiegler site (39RO23), which dominate the Woodland data base (Johnson 1973; Obey 1974; Syms 1982; Williams n.d.). Although recovered

skeletons from Woodland cemeteries greatly outnumber those of the Archaic, the Woodland still remains largely understudied (Bass 1981; Lass 1981). New discoveries such as evidence for pre-contact tuberculosis (Williams and Snortland-Coles 1986) and the presence of hydatid disease (Williams 1985b) demonstrate the potential wealth of information contained in these skeletons.

At A.D. 900 the PLAINS VILLAGE TRADITION is the last of the truly prehistoric stages in the Dakotas. The Village peoples as horticulturalists are characterized by a highly complex culture typified by the earthlodge and large farming communities. The historic Mandan, Hidatsa, and Arikara are the descendants of this tradition. Within the larger Plains Village tradition Lehmer (1971) recognizes two subdivisions, the Middle Missouri tradition followed by the Coalescent tradition (Gregg 1985). The earlier Middle Missouri Tradition consists of three variants. The Initial Middle Missouri variant ca A.D. 900-1400 marks the beginning of the Plains Village Tradition with the first appearance of Plains village peoples in the Big Bend and Bad-Cheyenne subareas of South Dakota. The Extended Middle Missouri variant, ca A.D. 1000-1550, occurs throughout both Dakotas This variant is also noted for the presence of fortifications surrounding the villages. The Terminal Middle Missouri variant, ca A.D. 1550-1675, is the concluding stage of the Middle Missouri Tradition. Like earlier villages, those of the Terminal Middle Missouri variant are also fortified but more heavily and are larger in size and fewer in number (Lehmer 1971).

The Coalescent Tradition and its four variants begins at least as early as the fourteenth century and is characterized by the movement of what are thought to be Caddoan speaking peoples into the Middle Missouri from the Central Plains. This began during the Initial Coalescent variant. Conflict during this and later times is clearly evident at the Crow Creek site (39BF11) where nearly 500 people were brutally massacred during the late 14th century (Owsley et al. 1977; Willey 1982; Zimmerman et al. 1981). The high incidence of nutritional and infectious disease at Crow Creek suggests that drought or other environmental factors played a role in this conflict (Gregg et al. 1981). By about A.D. 1400 during the Extended Coalescent variant, Caddoan speaking peoples occupied all of the Missouri trench in South Dakota. During the Post-Contact Coalescent variant after ca A.D. 1675 Plains peoples began to incorporate European elements into their culture. The horse made its first appearance on the Plains during this time. European diseases also were introduced resulting in devastating epidemics. It is during the Disorganized Coalescent variant ca A.D. 1780 that we enter the period of historical record.

Associated with the large, characteristic villages of the Coalescent Tradition are large cemeteries. These, like the villages themselves, are for the most part located on high terraces overlooking the Missouri River. The largest and best documented are those associated with the Extended and later Coalescent variants. These include the Initial Coalescent Crow Creek site (39BF11) (strictly speaking not a cemetery), the Extended and Post-Contact Coalescent Anton Rygh (39CA4) and Mobridge (39WW1) sites, the Post Contact Coalescent Larson site (39WW2), and the Disorganized Coalescent Leavenworth site (39CO9). In stark contrast, the Middle Missouri tradition is poorly represented by skeletal samples (Key 1983; Wood 1976).

2.2 Early Euro-American Contact

The lives of Native Americans are unfortunately poorly documented for the years prior to statehood in the Dakotas. As one of the last regions to be added to the United States and as an area far from the heavily populated east, Euro-American excursions into the Plains were uncommon. Among the earliest records of Euro-American activity in the northern Plains are those of the trappers and traders. They were among the first to enter this uncharted region and make contact with the various Native American peoples. One of the first to encounter the Mandan were the La Verendryes who set out from Fort La Reine (Portage La Prairie, Manitoba) in 1738 (Haxo 1941; Helgevold 1981). Other trader/explorers continued contact with the Mandan, Hidatsa and Arikara but the first permanent direct trade did not take place until 1795 when the Hudson's Bay Company established the Mandan villages of the upper Missouri as a hub trade location for the other tribes of the region (Wood and Thiessen 1985).

By the beginning of the 19th century the U.S. government began to take interest in the northern Plains and the lands to the west. At various times, explorers in the company of soldiers mounted explorations into the region. Of these the best known is the Lewis and Clark expedition of 1804 (DeVoto 1953; Meyer 1977). Although the journals of Lewis and Clark are concerned primarily with recording the events of the exploration party, numerous descriptions of the peoples of the Upper Missouri can be found. The artist George Catlin and Prince Maximilian of Wied also travelled through the upper Missouri Valley during this time and provide still other glimpses of early Euro-American contact among the Amerindians of the Northern Plains (Mooney 1975; Thwaites 1906). Included in these historic recordings are significant references to the occupation and abandonment of Coalescent villages (Bass et al. 1971; Lehmer 1971).

The rise and fall of these villages is directly linked to trade. The central and crowded location of the Mandan, Hidatsa, and Arikara villages which made them logical locations for permanent trading centers unfortunately made them ideal for the spread of epidemic infections for which they had no natural immunity. Francis Chardon, a trader at Fort Clark, provides dramatic firsthand description of the origin and the rapid decimation resulting from the 1837 smallpox epidemic (Abel 1932; Herman 1972). Although there are conflicting reports, this epidemic apparently originated with a passenger on the steamboat St. Peter which had stopped at Fort Clark on June 18th before travelling on to Fort Union (Coues, 1898; Trimble 1979). The first case, however, was not reported until July 14th as this journal entry of Chardon states:

> "...a young Mandan died today of the smallpox, several others have caught it..."

From there, the disease rapidly spread among Indians and non-Indians alike:

> "July 27...the smallpox is killing them up at the village..."
> "July 29...several Mandans died last night..."
> "August 7...six more died today..."

"August 8...four more died today...two thirds of the village are sick..."
"August 11...Mandans crossed to the other side of the river to encamp, leaving all that were sick in the village...I keep no account of the dead as they die so fast that it is impossible..."
"September 22...my youngest son died today..."

A telling statement of the severity of these infectious epidemics can be seen in the simple demographic observations made by the various Euro-Americans who traveled through the region. In the year 1780, during the early years of Euro-American contact, the Mandan and Hidatsa lived in 24 villages and numbered an estimated 12,000. Twenty-four years later they numbered only 3750 people living in just five villages. Data such as these support the concept that a `disease frontier` preceded the Euro-American western expansion (Utley 1984).

By the mid 1800s warfare and epidemic disease had decimated the tribes of the northern Plains (Meyer 1977). As a result there are few useful written accounts of early contact with the Plains Indians. Anthropologists must therefore rely heavily on the study of prehistoric human skeletons to provide answers to the question of prehistoric and early historic existence.

2.3 Early Archaeological Investigations

In one sense the earliest record of interest in the prehistory of the northern Plains can be attributed to explorers and travellers like Prince Maximilian of Wied. Both he and John Audubon during the early 1830s collected human skulls from recently abandoned villages along the Missouri River (Audubon and Coues 1898; Bass et al. 1971; Helgevold 1981; Thwaites 1906). However, it wasn't until the late 1800s and early 1900s that archaeologists began to take a scientific interest in the northern Plains. Montgomery (1906, 1908) and Nickerson (Capes 1963) excavated burial mounds throughout the Red River Valley and adjoining areas of the Northeastern Plains. The Hill-Lewis survey of 1881-1895 also stands out in the early history of archaeological investigation on the northern Plains (Keyes 1928). A. J. Hill, a philanthropist with an interest in history and archaeology, hired T. H. Lewis to conduct a survey of North American earthworks. Over a fifteen year period 18 states, including North and South Dakota, and Manitoba were mapped (Helgevold 1981:9; Zimmerman 1985). To the west in North Dakota, George Will and Herbert Spinden were among the first to conduct research in the Middle Missouri Plains (Lehmer 1971). Their excavation at the Double Ditch site (32BL8) in 1905, which included the recovery of human skeletons, was published as a part of an ethnographic account of the Mandan people (Will and Spinden 1906). George Will remained active in Middle Missouri archaeology (Will 1910, 1924, 1933). Will, together with Thad Hecker, produced a synthesis of prehistoric and early historic sites along the Missouri River valley in North and South Dakota (Will and Hecker 1944).

In South Dakota, M. W. Stirling of the United States National Museum can be counted among the first to conduct research along the Missouri River valley (Bass et al. 1971; Wedel 1955). Stirling excavated several cemeteries

including those at the Leavenworth site (39CO9) and the Mobridge site (39WW1). W. H. Over is another prominent name in the early archaeology of South Dakota (Helgevold 1981; Zimmerman 1985). Although Over never published his research, his rather extensive field notes have been compiled. These notes document that Over also removed human skeletons from the Leavenworth and Mobridge cemeteries, as well as from numerous other sites in South Dakota (Sigstad and Sigstad 1973). The last pre-salvage archaeologist of note is Alfred Bowers. Bowers' work, like that of Will and Spinden, was a combination of ethnohistory and archaeology and serves as a significant source of information concerning the Mandan and Hidatsa of contact and pre-contact times (Bowers 1948).

While scores of human skeletons were removed from cemeteries throughout North and South Dakota, analysis was often limited to a few simple measurements of skull diameter. In many places cemeteries were also destroyed either intentionally or unintentionally by the expansion of the railroads over the northern Plains (Dill 1966; Jenks 1932). As a result, while a significant amount of archaeological investigation took place during the late 19th and early 20th centuries little concrete information about the skeletal biology of these peoples emerged.

2.4 Salvage Archaeology, the River Basin Surveys, to the Present

The year 1946 initiated a new phase in the archaeology of the Northern Plains, especially along the Missouri Trench. In that year work was begun on the five dams that would eventually flood most of the Missouri river in the Dakotas (Helgevold 1981; Lehmer 1971). During the ensuing years "salvage" and "contract" archaeology would become common place terms. Through the Smithsonian Institution sponsored River Basin Surveys sites too numerous to list were identified (Cooper and Stephenson 1953; Lehmer 1971; Huscher and McNutt 1958). Given the magnitude of the problem only a small percentage of sites were actually excavated. Among these, however, were a large number of cemeteries. With limited time and funding even those sites that were `salvaged' were not always completely excavated resulting in continued exposure due to shoreline erosion (i.e., Anton Rygh (39CA4) and Mobridge (39WW1)).

What emerged with this rapid and extensive influx of human osteological remains was the subdiscipline of bioarchaeology. Human osteology had progressed from the simple study of the human skeleton to the study of human osteological remains in an archaeological context. At first, the focus of attention was on sites along the Missouri Trench. It is for this reason that these sites and accompanying cemeteries are better documented (Hughey 1980). For many of these sites emphasis has shifted from mere description to specific problem oriented research in skeletal biology (Bass 1981). This research includes work on skeletal growth (Jantz and Owsley 1984a, 1984b; Merchant and Ubelaker 1977), craniometric relationships, genetic affiliation, temporal changes, and microevolution (Jantz 1972, 1973, 1976, 1977a; Key 1983; Key and Jantz 1981; Owsley and Jantz 1978; Owsley et al. 1981), and paleodemography and paleopathology (Gregg and Gregg 1987; Gregg et al. 1965; Gregg et al. 1981; Owsley and Bass 1979; Owsley et al. 1977; Palkovich 1981; Steele et al. 1965). Elsewhere, especially for the eastern Woodland, research is still

primarily geared toward the compilation of basic raw data (e.g., Gill 1981; Williams 1985c).

A recent development in the bioarchaeology of the northern Plains was the analysis of the W. H. Over Museum human skeletal collection. Through lobbying by the Native American community the W. H. Over Museum collection was reinterred in 1985. Prior to its reinterment, a multifaceted team headed by Douglas Owsley, then with Louisiana State University, in conjunction with William Bass and the University of Tennessee, undertook the analysis of 475 skeletons representing 31 South Dakota sites (Douglas Owsley, personal communication, 1987). With increasing pressure by Native Americans to reinter museum curated human skeletal remains teamwork approaches to skeletal analysis are likely to become more common.

3.0 METHODS

3.1 General Procedures

Because the human skeletal remains described here are not part of a cohesive unit but rather are the result of random recovery, special consideration was necessary to organize the results. All human skeletal remains, artifacts, and faunal remains were catalogued using a letter-number label (i.e., a-34) (see Appendix B). The letter is the exhibit designation of the site or location from which the remains were recovered and the numeral is the serial catalogue number assigned to the individual human skeletal elements, artifacts, or faunal elements from that site. Only intact bones, artifacts, and faunal elements, or those pieces large enough to provide useful information, were identified in each inventory. In some cases small fragments of the same bone were grouped together, and the bone identified as fragmentary. Otherwise, small bone fragments were excluded from further identification and analysis. All references to individual skeletal elements, artifacts, and faunal remains follow this labelling system.

To reduce confusion concerning the term <u>burial</u>, it is used here only to refer to field identified bone concentrations. The term <u>individual</u>, on the other hand, refers to any discrete interment subsequently identified in the laboratory. In the case of multiple interments within one site and/or bone concentration the minimum number of individuals [MNI] interred was arrived at by enumerating those burials (senso lato) where a significant percentage of the skeleton was present, thus permitting the identification of a discrete individual. While "significant percentage" is subject to wide latitude in interpretation, single bones, isolated teeth, or other small percentages were normally excluded from this tabulation. Additional criteria such as the age and/or sex of the skeletal remains were also used where appropriate to segregate individuals. In the case of commingled remains, MNI counts were determined by tabulating the major bones of the skeleton, such as crania or long bones, and the whole skeleton when present. The highest number of any particular skeletal element was then interpreted as the most probable minimum number (Ubelaker 1978:30). Given the nature of the recovery of these skeletal remains the MNI count for each site and/or bone concentration may be less than exact and must be taken as a conservative best estimate. Every individual within a location, as designated by either an Exhibit or Catalogue No., was serially indexed (i.e., Individual No. 1).

Each tallied individual and/or burial/bone concentration was described with respect to condition and percentage of the skeleton present. Skeletal condition was categorized as good, fair, or poor. The criteria used to define these states are similar to those used by Owsley and Symes (1981:50):

- Good - unbroken and undeteriorated bone permitting most measurements.
- Fair - deteriorated and undeteriorated bone but still permitting most measurements.
- Poor - severely deteriorated bone permitting little if any measurement.

Where necessary, individual skeletal elements were also described with respect to their physical condition. When the individual element was not

intact it was described as either damaged or fragmentary. These two states are here defined as:

Damaged - has been broken, or has missing features or segments, accounting for less than 33% of the total length or surface

Fragmentary - has been broken, or has missing features or segments, accounting for more than 33% of the total length or surface.

Unless otherwise stated damaged and fragmentary elements are seen as artifacts of postmortem environmental conditions and not as the result of purposeful modification. The percentage of the skeleton present for each individual and/or bone concentration was derived by dividing the skeleton into four parts: the skull (and hyoid) accounting for 15%; the axial and thoracic skeletons accounting for 25%; and the upper and lower appendicular skeletons each accounting for 30%. Using this as a guide, burial percentage was arrived at by noting how many bones were present for each skeletal region. These estimates represent minimum percentages. Even under ideal circumstances some bones are likely to be lost, especially the hyoid, phalanges, and the coccygeal vertebrae. One hundred percent representation is an unlikely event; therefore, percentages of 90% or greater can be taken as complete skeletons.

Damaged bones were reconstructed only when such action would yield tangible results (for example, when reconstructing a femur would permit metric evaluation). Otherwise, no attempts were made to preserve or alter the condition of these remains.

During macroscopic examination, the burials were checked for the presence of cultural modifications of the skeleton. These included: red and yellow ochre staining, dissection or destructive bone alteration, and cremation. Other features of skeletal morphology, such as hypermuscularity and qualitative differences in bone structure, were also recorded. When present, anomalous and pathologic states were identified and diagnosed (see Section 6.0). Anomalous states are defined as non-pathologic physical characteristics which, while within the range of normal variation, are nonetheless too rare or unusual to be so identified. Pathologic states, on the other hand, are identified as any disease related modifications to the skeleton. Pathologic diagnoses were derived from several sources (Brothwell and Sandison 1967; Gregg and Gregg 1987; Morse 1978; Ortner and Putschar 1981; Steinbock 1976; Zimmerman and Kelley 1982). It should be kept in mind that pathology can only be identified for those cases where bone has been altered. Many acute infectious episodes, as well as serious traumas, may not be evident even though they may be prime contributors to mortality.

All intact crania were routinely photographed using both black and white prints and color transparencies (see Appendix C). All anomalous and pathologic features as well as significant artifacts were similarly documented. Plaster dental casts were also made for those dentaries that were sufficiently intact or which displayed anomalous and/or pathologic states.

3.2 Demography

The demographic analysis of these skeletal remains was very simple; the determination of the age and/or sex, if possible, for each individual. For juvenile skeletons four criteria were used to determine age at death. These were eruption and development of the deciduous and permanent dentition, epiphyseal union, long bone diaphysis length, and the morphology of the temporal bone (Bass 1971; Brothwell 1981; Moorees et al. 1963; Ubelaker 1978; Weaver 1979). Adult age was assessed on the basis of pubic symphysis morphology and on the attrition of the permanent molars (Brothwell 1981; Gilbert and McKern 1973; Stewart 1979; Ubelaker 1978). Preference was given to the morphology of the pubic symphysis, but this was not always present. Those adults lacking these two features could only be approximately aged by using criteria such as complete epiphyseal union (+23 years) or other imprecise, less sensitive indicators, as degenerative arthritis or extreme molar attrition (+40 years), and cranial suture closure (Krogman and Iscan 1986).

Sexing was attempted only for adult skeletons. Criteria preferentially included characteristics of the pelvis and skull. Using the pelvis and skull, 21 characteristics were chosen (Tables 4 and 5). Following the procedure described by Praschma and Sundick (1980), each character was separated into five sexing categories each with a different numerical score: hypermasculine (+2), masculine (+1), neutral (0), feminine (-1), and hyperfeminine (-2). The traits are scored in one of these five categories. The characteristics in turn were weighted as to their sexing sensitivity. Using trait scores and their individual weights, a numerical sexing coefficient was calculated using the formula:

$$M = W_x/W$$

where M is the sexing coefficient (ranging from +2 to -2)
[M_p = sexing coefficient for the pelvis and M_s = sexing coefficient for the skull]

W_x is the sum of individual trait scores multiplied by their respective weights

W is the sum of weights for scored traits

Individuals with negative coefficients were classified as female and those with positive scores as male. Where the pelvis and skull were absent or fragmentary, sexing was accomplished using the less accurate indicators of the size and robusticity of the skeleton (Krogman and Iscan 1986).

3.3 Metric and Non-metric Description

One of the primary goals of this skeletal analysis was the construction of a descriptive data base. This provides the principal means by which skeletal populations are compared and ethnic associations established (e.g., Jantz 1977b; Key 1983; Ossenberg 1974a; Owsley et al. 1981). These data function as permanent descriptors for future reconstruction of a population's skeletal biology. While a small number of metric dimensions were used for ethnic identification and cranial description, the majority of collected data were designed for potential future use.

Descriptive data come in two forms: metric, the physical measurement of bone dimensions; and non-metric, the enumeration of discrete morphological features. While the fundamental premise behind the use of these data is their genetic origin, environmental influence, such as that of artificial cranial deformation, cannot be overlooked as a contributing factor (cf., Corruccini 1974; Grüneberg 1963; Ossenberg 1970, 1976). Metric and non-metric data therefore characterize both genetic and environmental features of a skeletal population.

Metric dimensions were derived from several sources (Bass 1971; Brothwell 1981; Comas 1960; Corruccini and Ciochon 1976; El-Najjar and McWilliams 1978; Farrallay and Moore 1975; Feldesman 1976; Hinton and Carlson 1979; Howells 1973; Hrdlicka 1939; Jantz and Willey 1983; Lavelle 1972; Lisowski et al. 1974; McHenry 1975, 1978; McHenry and Corruccini 1975, 1978; McHenry et al. 1976; Rightmire 1970; and Susman 1979). These were chosen for ease of replication. In this way it was hoped that inter and intra-observer error, a common problem with metric assessment, was minimized (Utermohle and Zegura 1982). While there is no general agreement as to what constitutes a sufficient metric data base the philosophy of this analysis was to provide maximum description. Bass (1971) served as the foundation with additional metrics included to provide further description. Standard anthropometric devices (sliding caliper, cranial caliper, coordinate caliper, osteometric board, and graduated tape) were used. All measurements were taken to the nearest tenth of a millimeter and unless otherwise stated are recorded in millimeters (see Appendix D). Measurements were omitted if the bone was damaged, warped, or otherwise altered to the point that the reliability of the measurement was jeopardized. No estimated measurements were employed. For paired metrics, both right and left sides were recorded. For juvenile skeletons, only diaphysis length or similar dimensions were recorded.

According to Ossenberg (1970:358), discrete traits fall into one of two categories; hypostotic and hyperostotic. Hypostotic traits, such as the foramen of Hushke (an aperture in the tympanic plate), are the result of insufficient ossification. Hyperostotic traits, such as the paracondylar process, result from an excess of ossification. The former tend to occur more often in females, have a preference for the right side, and are age-regressive. While the latter are age-progressive, have a male preference, and occur more often on the left side. Thus both age and sex are additional variables to be considered when using non-metric traits. One drawback to the use of non-metric traits in biological distance is the requirement of population trait frequencies. Individual skeletons cannot be used in the same manner as with metric analysis (i.e., discriminant function). While non-metric traits are primarily used as population descriptors, they can also serve as a focus of analysis concerning their individual etiologies (e.g., Finnegan and Marcsik 1980; Ossenberg 1974b; Williams 1982b).

Discrete descriptors were chosen with a similar rationale to that of the metrics, to provide maximum data. Following; Berry and Berry (1967), Carpenter (1976), El-Najjar and McWilliams (1978), Finnegan (1978), Finnegan and Faust (1974), Kelley (1979), Ossenberg (1970, 1974a, 1976), and Saunders (1978), a variety of cranial and infracranial characteristics were used. An attempt was made to use those with the least ambiguity in scoring and

identification. These data were generally recorded for only adult skeletons. Most traits were scored by noting the simple presence or absence of the characteristic. For those traits with varying levels of expression forming more or less a continuum (i.e., the paracondylar process), character states were scored numerically (0-3). Paired traits were scored for both right and left sides (see Appendix E for specific character state scoring codes).

Traditionally the skull has been the focus of both metric and non-metric analysis, especially with regards to biological distance. Within the limitations of both approaches, metric and non-metric traits have been successfully used in the linkage of extant and prehistoric populations (cf., Buikstra 1976; Corruccini 1974; Ossenberg 1974a, 1976, 1977). More recently, some attention has switched to the use of infracranial metrics and non-metrics (Snyder-Winder 1981; Saunders 1978; Zobeck 1983). However, the skull is still seen as the most reliable indicator of ethnic identity and biological distance. For this analysis, the discriminant function devised by Jantz (1976:31) proved invaluable. This statistic uses 12 craniometrics to differentiate Mandan from Arikara crania.

3.4 Dentition

Although neglected or downplayed in many skeletal analyses, teeth play an equally important role in skeletal description by providing additional descriptive data and by providing evidences of population stress and dietary adaptation (Goodman et al. 1980; Hinton 1982; Patterson 1984; Smith 1984). Those deciduous and permanent teeth which were undamaged and relatively unworn were described using metric and non-metric characteristics (Kraus et al. 1980; Sciulli 1977, 1979; Wheeler 1974). Maximum mesial-distal length and buccal-lingual breadth measurements were made for right and left teeth. These dimensions were measured to the nearest tenth of a millimeter using a Helios needle point dial caliper. Discrete morphological characteristics were tallied for both the right and left sides (see Appendix F).

Acquired characteristics were also recorded and where appropriate, quantified. These included occlusal attrition, interproximal wear, caries and abscess incidence, periodontal disease, and enamel hypoplasia. Using the scale devised by Smith (1984) occlusal attrition was routinely assessed for the first molar. Interstitial or interproximal wear is another form of attrition which takes place at the contact points between adjacent teeth. The resulting wear facets were measured at the contact points between the fourth premolar and first molar, the first and second molars, and the second and third molars (Hinton 1982; Wolpoff 1971). These wear facets (maxillary and mandibular) were measured to the nearest hundredth of a millimeter for both left and right sides using a Helios needle point dial caliper.

Carious lesions were identified by tooth location, severity, and by type; radicular, smooth surface, or pit/fissure (White 1975). Like caries, abscesses were identified by tooth location, severity of alveolar destruction, and whether tooth exfoliation had taken place.

Periodontal disease is a complex pattern of inflammation of the gingiva and

Table 4. Sexing criteria: Pelvis.

Feature	Weight	Grade -2	Grade -1	Grade 0	Grade 1	Grade 2
preauricular sulcus	3	deep	less deep	medium	slight presence	absence
sciatic notch	3	very wide U	transitory	medium	V shape	narrow V
pubic angle	2	obtuse	obtuse to 90^{o}	90^{o}	acute	strongly acute
arc compose	2	--------double curve--------			--------single curve------	
ventral arc	2	strong	present	slight	trace	absent
sacro-iliac articulation	2	very raised	raised	medium	slight	flat
obturator foramen	1	triangular sharp rims	triangular	no class.	oval	oval rounded rims
iliac crest	1	very flat S	flat S	middle	S shape	accentuated S
greater pelvis	1	very low broad	low broad	intermediate	high narrow	very high narrow
true pelvis	1	very broad oval	broad oval	intermediate	narrow heart shape	very narrow heart shape
subpubic concavity	1	very concave	concave	intermediate	slight concave	straight
ischio-pubic ramus	1	narrow ridge	narrow	intermediate	broad no ridge	broad flat
sacrum	1	very broad-low	broad-low	narrow-medium	narrow-high	narrow-very high

Table 5. Sexing criteria: Skull.

Feature	Weight	Grade -2	-1	0	1	2
glabella	2	smooth	slight	delimited	marked	massive
mastoid	2	very small	small	medium	large	very large
external occipital protuberance	2	smooth	slight	medium	large	very large
orbits	2	very sharp circular	sharp circular	intermediate	slight-rounded	rounded-squared
mentum	2	small	rounded	medium	prominent	very prominent
zygomatic arch	1	very thin smooth	thin smooth	medium	thick irregular	very thick irregular
temporal line	1	absent	slight	medium	present	marked
mandibular angle	1	smooth	incipient eminences	moderate	marked	strong eminences

the alveolar bone. The alveolar bone progressively degenerates and resorption of the alveolar margin takes place. Several methods exist for quantifying the level of periodontal disease (Costa 1982; Patterson 1984). The simplest procedure involves the direct measurement of the degree of alveolar resorption. Using a Helios needle point dial caliper the distance from the cementum-enamel junction to the alveolar margin was measured. Preferentially this measurement was taken for the first molar. The first molar (maxillary or mandibular as available) was chosen for this measurement primarily because past experience has shown it to be usually present and to display the greatest degree of alveolar resorption. No further assessments of periodontal inflammation were made other than to note whether tooth exfoliation had taken place.

Crown surfaces were also macroscopically examined for the presence of hypoplastic episodes. Enamel hypoplasias or disruptions in enamelogenesis can occur as regular bands or as pit-like disruptions of the enamel surface (El-Najjar et al. 1978). All hypoplasias observed were identified by type and severity. Following the procedure outlined by Goodman et al. (1980) the location of each hypoplastic episode was marked by measuring the distance from the cementum-enamel junction to the hypoplasia (Patterson 1984) These distances were measured to the nearest tenth of a millimeter using a Helios

needle point dial caliper.

During gross macroscopic examination the presence and absence of other features such as malocclusion, enamel chipping and fracturing, and calculus deposits were noted.

3.5 Radiographic Analysis

Most anomalous and pathologic conditions are identified on the basis of gross morphology. Some observed features are ambiguous, others like osteoporosis, display no external evidence. For these reasons, a limited series of radiographs were made to determine what possible internal morphologies were associated with various anomalous/pathologic conditions. The bones selected for analysis were those for which radiography could supplement, as well as supply information beyond that obtained through gross macroscopic observation (see Section 6.0). Included was an attempt to identify the presence and range of Harris' lines expression in juvenile and young adult long bones (see Section 6.33). Standard roentgenographic techniques were used in the exposure of each radiograph (Morse 1978:62; Ortner and Putschar 1981:48).

Additionally, all intact crania were routinely radiographed to create a permanent record. In each case a left lateral and an antero-posterior exposure was made (see Appendix G).

3.6 Stature Estimation

For North American prehistoric skeletons, two procedures are commonly used to estimate adult stature. The first, developed by Trotter and Glesser (1958:120), is a formula based on Mongoloid males who were killed during the Korean Conflict. While this formula appears well suited for North American populations, it overestimates female stature (Ubelaker 1978:45). Genoves (1967:76) also developed a stature formula, this one based on extant Mesoamerican male and female cadavers. Although the Genoves formula is not as regionally applicable, it does take into account sex differences in stature estimation. For this reason, the Genoves formula was chosen. Stature was determined using femur length as the basis for formula estimation. When at all possible the left femur was used. When this was not present the right femur was substituted. Because the Genoves formula is sex specific, stature estimation was performed only for sexed adults (see Section 6.34).

3.7 Paleodietary Analysis

As per the Scope-Of-Work (see Appendix A) eight sites were chosen for a more detailed analysis, specifically in the form of trace mineral and stable isotope testing (see Section 7.0). These sites were:

Red Horse Hawk (39CO34) - Exhibit A, Catalogue No. 1
Anton Rygh (39CA4) - Exhibit B, Catalogue No. 2A

Anton Rygh (39CA4) - Exhibit B, Catalogue No. 2B
Howes (39HU203) - Exhibit H, Catalogue No. 8
39LM59 - Exhibit S, Catalogue No. 20A
Fort Lookout II (39LM57) - Exhibit T, Catalogue No. 20B
Scalp Creek Cemetery (39GR32) - Exhibit U, Catalogue No. 21
39LM256 - Exhibit V, Catalogue No. 22
39ST126 - Exhibit W, Catalogue No. 23

The levels of seven trace minerals (zinc, manganese, iron, magnesium, copper, strontium, and calcium) were determined. Each sample was a minimum of ten grams in weight. Given the nature of these remains no consistent skeletal element was utilized for analysis. This analysis was carried out at the United States Department of Agriculture, Human Nutrition Research Center at Grand Forks, North Dakota (see Appendix H). Two stable isotope levels (C13 and N15) were also determined. This analysis was carried out in conjunction with radiocarbon dating (see Section 3.8) by Geochron Laboratories, Cambridge, Massachusetts (see Appendix I).

3.8 Radiocarbon Analysis

As per the Scope-Of-Work eight sites (see Appendix A and Section 3.7) were targeted for radiocarbon dating. In addition to bone collagen samples, one charcoal sample (39LM59 - Exhibit S, Catalogue No. 20a) was also sent for analysis. Where possible so as to ensure a sufficient quantity of bone collagen a minimum sample of 400-500 grams of bone was sent. Preferentially the dense long bones were chosen. These samples were processed by Geochron Laboratories, Cambridge, Massachusetts. In the case of the Scalp Creek Cemetery (39GR32 - Exhibit U, Catalogue No. 21) the recovered bone was not sufficient in quantity for radiocarbon testing. Instead, an additional sample was sent for site 39LM256 (Exhibit V, Catalogue No. 22). To cross check the radiocarbon dating this sample was processed by the Radiocarbon Laboratory, Southern Methodist University (see Appendix J). All radiocarbon dates were calibrated following the procedure outlined in Stuiver and Pearson (1986).

3.9 Artifact and Faunal Analysis

In addition to the human osteological remains, artifacts and faunal elements were recovered. These were macroscopically examined and separated into two groups; artifacts and modified faunal elements, and unmodified faunal elements. Each group was analyzed using appropriate techniques (see Sections 8.0 and 9.0). Artifacts including modified faunal elements were recovered from eight sites;

Red Horse Hawk (39CO34) - Exhibit A, Catalogue No. 1
Anton Rygh (39CA4) - Exhibit B, Catalogue No. 2B
Blue Blanket Point (39WW98) - Exhibit I, Catalogue No. 9/10
Blue Blanket Point (39WW98) - Exhibit O, Catalogue No. 16
Okobojo Point - Exhibit P, Catalogue No. 17
39LM59 - Exhibit S, Catalogue No. 20A

39LM256 - Exhibit V, Catalogue No. 22
39ST126 - Exhibit W, Catalogue No. 23
39BR13 - Exhibit X, Catalogue No. 25

Unmodified faunal elements were recovered from ten sites;

Red Horse Hawk (39CO34) - Exhibit A, Catalogue No. 1
Anton Rygh (39CA4) - Exhibit B, Catalogue No. 2B
Blue Blanket Recreation Area - Exhibit D, Catalogue No. 4
Mobridge (39WW1) - Exhibit G, Catalogue No. 7
Blue Blanket Point (39WW98) - Exhibit I, Catalogue No. 9/10
Elm Creek Recreation Area - Exhibit N, Catalogue No. 15
Okobojo Point - Exhibit P, Catalogue No. 17
Fort Lookout II (39LM57) - Exhibit T, Catalogue No. 20B
39LM256 - Exhibit V, Catalogue No. 22
Sunrise Hill (39CH210) - Exhibit Y, Catalogue No. 27

4.0 BURIAL AND SITE DESCRIPTIONS

4.1 Introduction

A total of 55 discrete individuals (MNI=55) were identified from the human skeletal remains recovered at the 29 Missouri River locations in South Dakota (Table 6). Thirty-eight of these were adults, 18 females, 13 males, and 7 of undetermined sex. Fifteen were juveniles (<16 years of age) and 2 were of indeterminate age.

Burial mode was recorded for the burials at 10 of the 29 locations. Of these, four were primary-flexed interments, four were secondary bundles, and two were pit burials of undetermined nature. The tallied individuals were represented by varying proportions of the skeleton, from less than 1% to nearly complete at 95%. These percentages, however, have less to do with burial mode and mortuary practices than with the nature of recovery. Preservation likewise varied considerably, from good to very poor. By site the majority of burials (41%) were in poor condition, slightly fewer (34%) were in a fair state of preservation, while the burials from only seven locations (24%) could be described as well preserved. Although other factors such as skeletal and temporal age played a part, the level of preservation appears to be in direct relation to the degree of atmospheric and/or water exposure.

4.2 Red Horse Hawk site (39CO34) - Exhibit A, Catalogue No. 1

In August of 1985 the South Dakota office of the Corps of Engineers was notified by the South Dakota Department of Transportation that a human skull was eroding from the beach at the Red Horse Hawk site (Nowak 1985a). Mr. Timothy Nowak, Corps of Engineers South Dakota field archaeologist, visited the site. A primary burial of an adult female was recovered. The body had been placed in a flexed position on its right side in a pit lined with fire-cracked rock. Artifacts and faunal remains were also recovered (see Sections 8.2 and 9.2).

The Red Horse Hawk site is a fortified earthlodge village located in Corson County northwest of the City of Mobridge, South Dakota. The site originally overlooked the confluence of the Missouri and Grand Rivers (Haberman 1978, 1982). Today the site is located just north of U.S. Highway 12 on a small peninsula which also includes the Indian Memorial Recreation Area (Figure 3). The site falls within the Post-Contact Coalescent with a probable date within the 18th century (Bowers 1963). The site was extensively excavated by Alfred Bowers during 1962 and 1963 for the Smithsonian Institution, River Basin Surveys. No burials were recovered during these excavations. The Davis site (39CO14), an Extended Coalescent earthlodge village, is located several hundred meters to the northwest. Haberman (1978, 1982) reports that some confusion exists as to the correct name and location of these two sites as originally reported by W.H. Over (Sigstad and Sigstad 1973). Also located on the same peninsula is the Travis I site (39CO213). This village contains both Extended Middle Missouri and Extended Coalescent components (Haberman 1982).

Table 6. Inventory of identified individuals.

Individual	Age	Sex	% Recovered	Preservation	Burial Mode
39C034					
no. 1	32-52	female	95	good	primary-flexed
39CA4					
no. 1	40+	male	40	fair-poor	unknown
no. 2	16-19	na	30	fair	log-lined pit
no. 3	40+	na	20	fair	log-lined pit
no. 4	0-0.5	na	5	fair	log-lined pit
39SL4					
no. 1	30-35	male	15	good	unknown
no. 2	30-35	female	15	good	unknown
Blue Blanket Recreation Area - Exhibit D					
no. 1	40-45	male	50	good	unknown
Blue Blanket Recreation Area - Exhibit E					
no. 1	23-39	male	50	fair	unknown
Fort Thompson Area					
no. 1	8-8.5	na	30	good	unknown
39WW1					
no. 1	0-0.5	na	10	poor	unknown
no. 2	32-52	female	60	good	unknown
39HU203					
no. 1	30-39	male	50	poor	unknown
39WW98 - Exhibit I					
no. 1	0-1	na	5	fair	unknown
no. 2	4.5-5.5	na	15	fair	unknown
no. 3	17-23	female	35	fair	unknown
no. 4	40-47	female	5	good	unknown
no. 5	50+	male	45	good	unknown

Table 6. Continued.

Individual	Age	Sex	% Recovered	Preservation	Burial Mode
39WW98 - Exhibit J					
no. 1	ca 12	na	25	fair	bundle/cedar bark
Pike Haven Recreation Area					
no 1.	ca 17	female	15	fair	unknown
39LM27					
no. 1	ca 16	na	2	poor	unknown
no. 2	8+	na	5	poor	unknown
no. 3	10+	na	5	poor	unknown
Brush Creek Area					
no. 1	ca 50	female	60	poor	unknown
Elm Creek Recreation Area					
no. 1	6-7	na	5	fair	unknown
no. 2	+23	na	10	fair	unknown
no. 3	+23	na	10	fair	unknown
39WW98 - Exhibit O					
no. 1	11-12	na	60	poor	bundle
Okobojo Point					
no. 1	6-7	na	80	poor	primary-pit
no. 2	0-1	na	20	poor	unknown
LeCompte Catholic Cemetery					
no. 1	22-40	female	1	good	cemetery-coffin
Prairie Dog Bay					
no 1.	+23	na	25	poor	unknown
39LM59					
no. 1	32-52	female	10	poor	pit
no. 2	52-59	female	5	poor	pit

Table 6. Continued.

Individual	Age	Sex	% Recovered	Preservation	Burial Mode
39LM57					
no. 1	45+	female	1	poor	unknown
no. 2	1-3	na	1	poor	unknown
no. 3	20-25	na	1	poor	unknown
39GR32					
no. 1	ca15	na	7	poor	bundle
no. 2	+23	na	2	poor	bundle
39LM256					
no. 1	40-45	male	15	good	bundle
no. 2	4-6	na	15	fair	bundle
no. 3	2-3	na	15	fair	bundle
no. 4	0.5-1.5	na	5	fair	bundle
no. 5	40-45	female	15	fair	bundle
no. 6	30-35	female	15	fair	bundle
no. 7	23-37	male	20	fair	bundle
39ST126					
no. 1	44-54	female	90	poor	primary-flexed
39BR13					
no. 1	+23	female	5	fair	unknown
no. 2	16-23	female	15	fair	unknown
Exhibit X					
no. 1	+23	male	10	fair	unknown
no. 2	+23	male	10	fair	unknown
39CH210					
no. 1	30-40	female	75	poor	primary-flexed

Table 6. Continued.

Individual	Age	Sex	% Recovered	Preservation	Burial Mode
39WW203					
no. 1	+23	male	15	fair	unknown
Platte Creek Recreation Area					
no. 1	20-25	female	15	fair	unknown
39BR10					
no. 1	+23	male	5	poor	unknown

This region of Lake Oahe is marked by numerous other archaeological sites including the Leavenworth site, the Anton Rygh site, and the Mobridge site (Figure 4). The Leavenworth or Lewis and Clark site (39CO9) is a historic Arikara village and cemetery and is located 10 miles north of Mobridge on the right bank of the Missouri River (Bass et al. 1971). The Anton Rygh site (39CA4), a multicomponent fortified earthlodge village, is located on the left bank of the Missouri River just north of the mouth of the Grand River (Knudson et al. 1983). The Mobridge site (39WW1), a protohistoric Arikara village and cemetery, is also located on the east bank of the Missouri River just north of the city of Mobridge (Wedel 1955). Skeletal remains recovered from the Mobridge and Anton Rygh sites were included in this project and are described below (see Sections 4.3 and 4.8).

The single recovered burial is of a female (M_p=-1.4, M_s=-1.0) with an age, based on the pubic symphysis, of 32-52 years. The skeleton is in a good state of preservation and is nearly complete (95%). Only the small bones of the hands and feet are not represented. The left anterior third of the superior surface of the cranium is bleached indicating a lengthy period of atmospheric exposure prior to discovery (Figure 5a). The skull of this individual is intact (Figure 5b). It is rounded, but very long and narrow (Cranial Index [CI] =69.5), and high (Auricular Mean Height Index [AMHI] =73.1).

An uncorrected bone collagen radiocarbon date obtained from this individual places this burial at 950 + 75 B.P. (GX-13399). The calibrated date of 915 B.P. (944 - 776 B.P.) falls early in the period for the Extended Middle Missouri variant. The artifacts recovered appear to support this cultural-historical placement (see Section 8.2). The cranial morphology is likewise atypical of the Post-Contact Coalescent. Arikara crania are generally shorter and well-rounded (Bass 1964; Bass et al. 1971). Using the discriminant function developed by Jantz (1976:31) to distinguish Mandan from Arikara skulls, the discriminant score (0.590) calculated for this skull falls on the Mandan side of the sectioning point. Although this individual was recovered within the perimeter of the Red Horse Hawk site the bioarchaeological pattern is inconsistent with a Post-Contact Coalescent association. Given the level

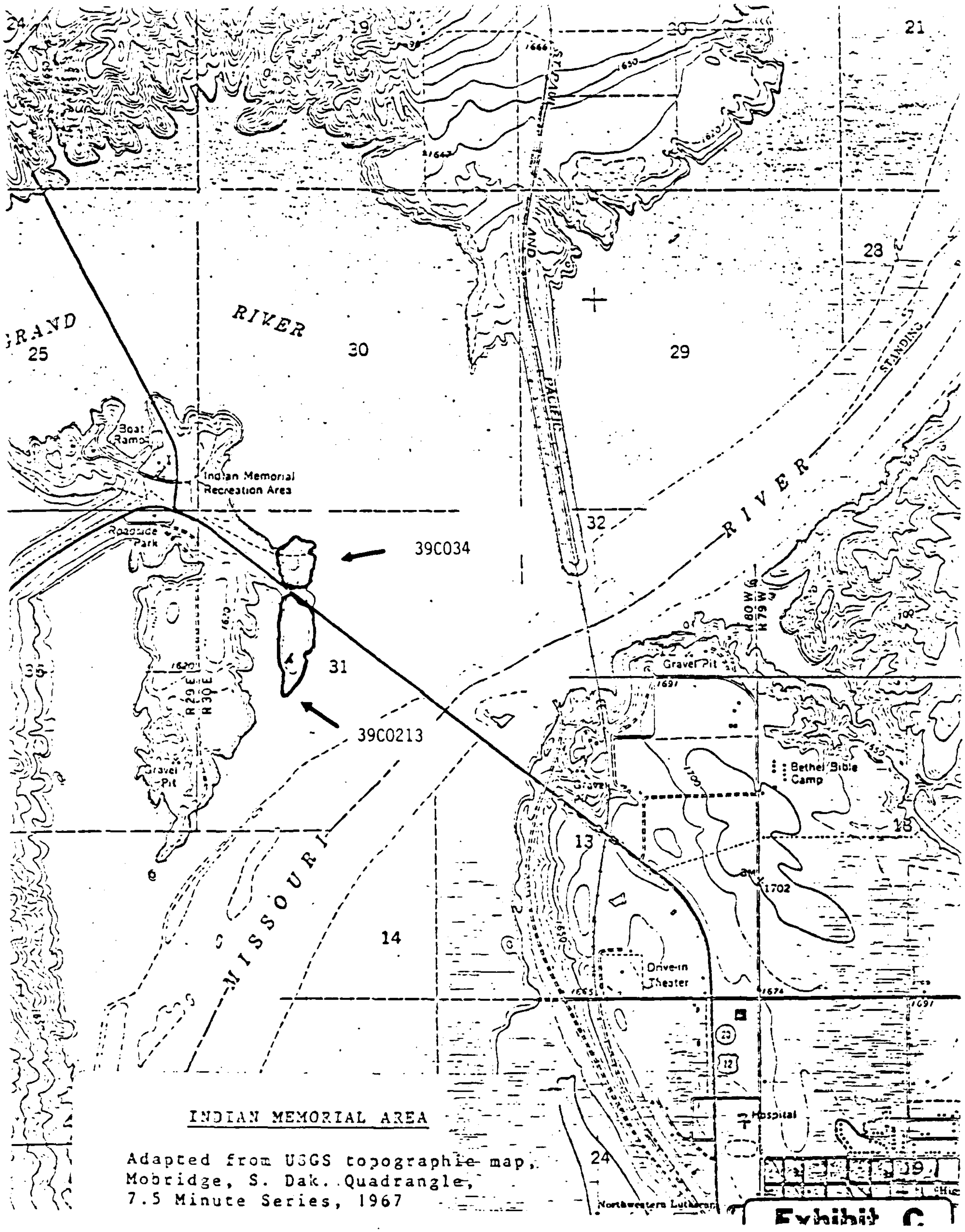


Figure 3. Site map, Red Horse Hawk (39C034).

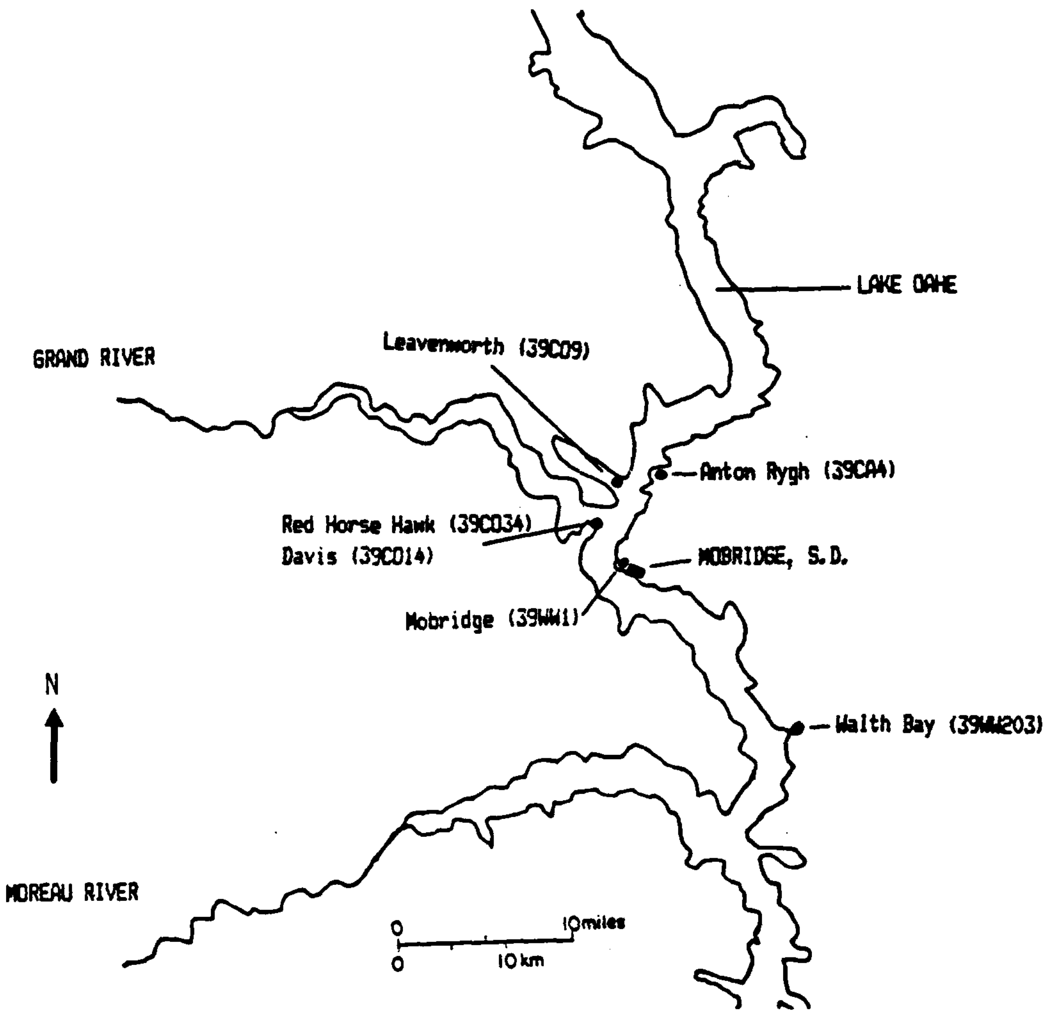
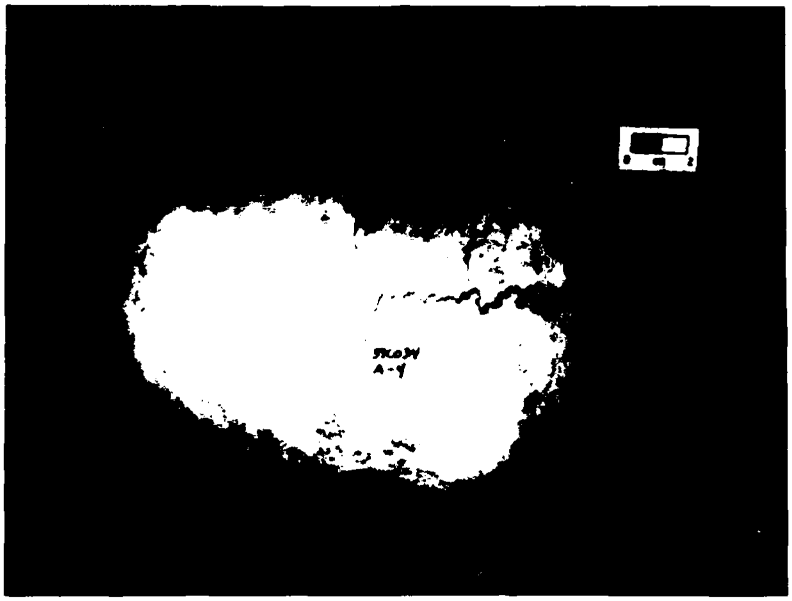
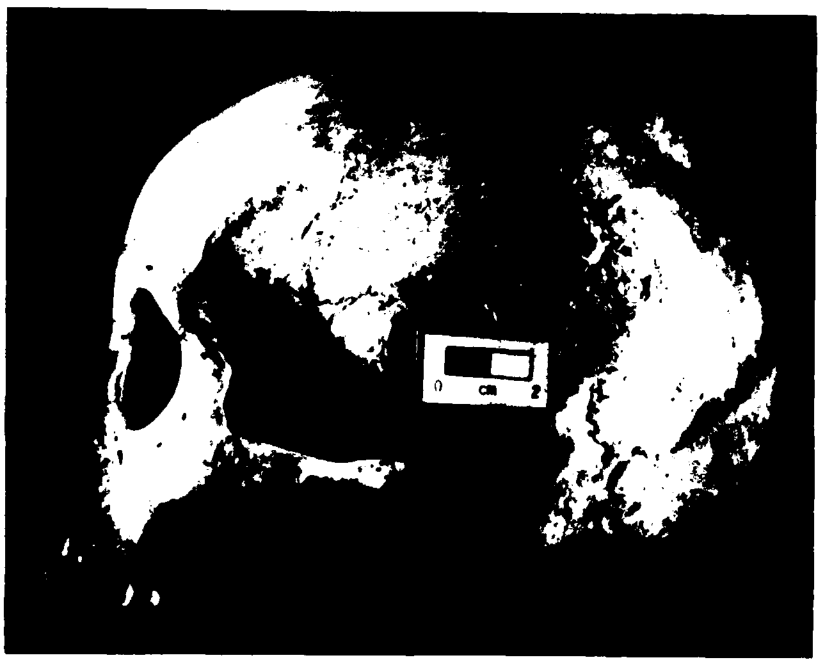


Figure 4. Archaeological sites in the Mobridge, South Dakota area (after Weston et al. 1979).



a.



b.

Figure 5. Cranium recovered from Red Horse Hawk (39C034) (Exhibit A, Catalogue No. 1). a: superior, b: left lateral.

of prehistoric activity in this area this burial may be associated with one of several sites, including Travis I (39CO213) which has an Extended Middle Missouri component.

4.3 Anton Rygh Site (39CA4) - Exhibit B, Catalogue Nos. 2A and 2B

In August 1985 Mr. Timothy Nowak, Corps of Engineers field archaeologist, was notified that a fisherman had found human bone eroding from a cutbank at Rorgo Bay. The bones were no longer in-situ but had been placed in a pile on the beach. The partial skeleton of an adult male was recovered. The skeleton was in poor condition, exhibiting postmortem damage from atmospheric and/or water exposure. While inspecting the site Nowak discovered a second disturbed burial 610 meters southwest of the first burial (Figure 6). Although this too had been disinterred, the burial pit had been lined with cedar logs (Nowak 1985a).

The Anton Rygh Site is a multicomponent fortified earthlodge village located in Campbell County on the east bank of the Missouri river near the confluence of the Grand River nine miles north of Mobridge, South Dakota. The site covers nearly 12 acres marked by at least 50 earthlodge depressions. Components identified from the site include Extended Middle Missouri as well as Extended and Post-Contact Coalescent. There is a long history of archaeological activity at this site. The site was first visited and recorded by W.H. Over who surface collected during the 1920s (Knudson et al. 1983). William Duncan Strong first excavated the site in 1932 but did not recover any burials. The most significant work at the site took place under the direction of Alfred Bowers who during the years 1957 through 1959 conducted a major excavation at the site prior to its inundation by Lake Oahe. Although no cemetery was located at least 58 interments were identified and recovered. The more complete burials were generally primary, often in a flexed position. These were commonly located in refuse or cache pits or under house floors (Knudson et al. 1983:40). In 1965 wave erosion exposed additional burials at the site. These and others (a total of 34 individuals) were recovered by William Bass during this and the following year. Since that time human remains have continued to erode out along the beach horizon (Bass 1983; Willey et al. 1987).

The first burial recovered (Catalogue No. 2A) is a partial skeleton of an adult male (M_D=1.7). Individual no. 1 (Table 7) is represented by approximately 40% of the skeleton. The hands, feet, and most of the skull are missing. The preservation of the skeletal elements is poor with moderate damage due to atmospheric and/or water exposure. The age of this individual is unknown, but the severity of arthritic inflammation (see Section 6.3) suggests an age in excess of 40 years.

The second burial (Catalogue No. 2B) represents commingled remains of three individuals. Individual no. 2 is a subadult of unknown sex. The sequence of epiphyseal union indicates an age of 16-19 years. This individual is represented by approximately 30% of the skeleton; a fragmentary left innominate, left and right tibiae, left and right tali, left femur, and right patella. Individual no. 3 is an adult of unknown age and sex. This

Table 7. Individuals recovered from Anton Rygh (39CA4).

Individual	Burial	Age	Sex	% Recovered
1	1	40+	male	40%
2	2	16-19	na	30%
3	2	40+	na	20%
4	2	0-0.5	na	5%

individual is represented by a left scapula, left clavicle, left and right calcanei, left humerus, left radius, and a right femur. All of these skeletal elements display complete epiphyseal union and arthritic inflammation (see Section 6.4) consistent with an age of 40+ years. Individual no. 4 consists of the fragmentary skull of an infant, whose relative level of development and lack of erupted teeth indicates an age of 0-0.5 years. Like the remains of the first burial these too are poorly preserved displaying bleaching and longitudinal splitting consistent with atmospheric degradation.

Two bone collagen radiocarbon dates were obtained from this site, one from each burial. The first date utilized bone collagen from Individual no. 1 (burial no. 1) producing an uncorrected date of 555 ± 75 B.P. (GX-13400). The second date utilized bone collagen from Individual no. 3 (burial no. 2) and produced an uncorrected date of 540 ± 75 years B.P. (GX-13401). The respective corrected radiocarbon dates of 548 B.P. (648 - 540 B.P.) and 543 B.P. (644 - 591 B.P.) place these two burials within the period overlapped both by the Extended Middle Missouri and Extended Coalescent variants. The close correspondence between these two dates suggests interment at or about the same time and are consistent with the previously identified components from Anton Rygh.

Artifacts and a single faunal element were recovered with burial 2 (see Sections 8.3 and 9.3). These were undiagnostic of the cultural-historical position of these skeletal remains. In the absence of cranial elements no further identification of these four individuals can be made.

4.4 Sully Site (39SL4) - Exhibit C, Catalogue No. 3

Collectors turned over to the Corps of Engineers two crania and a mandible. No other information is available about these remains.

The Sully Site is located in Sully County on the left bank of the Missouri River at the confluence with Sully Creek. Although this site, like others along the Missouri trench, has a long excavation history, little documentation exists for this large (250-300 house depressions) earthlodge village (Cooper and Stephenson 1953; Sigstad and Sigstad 1973). However, the associated

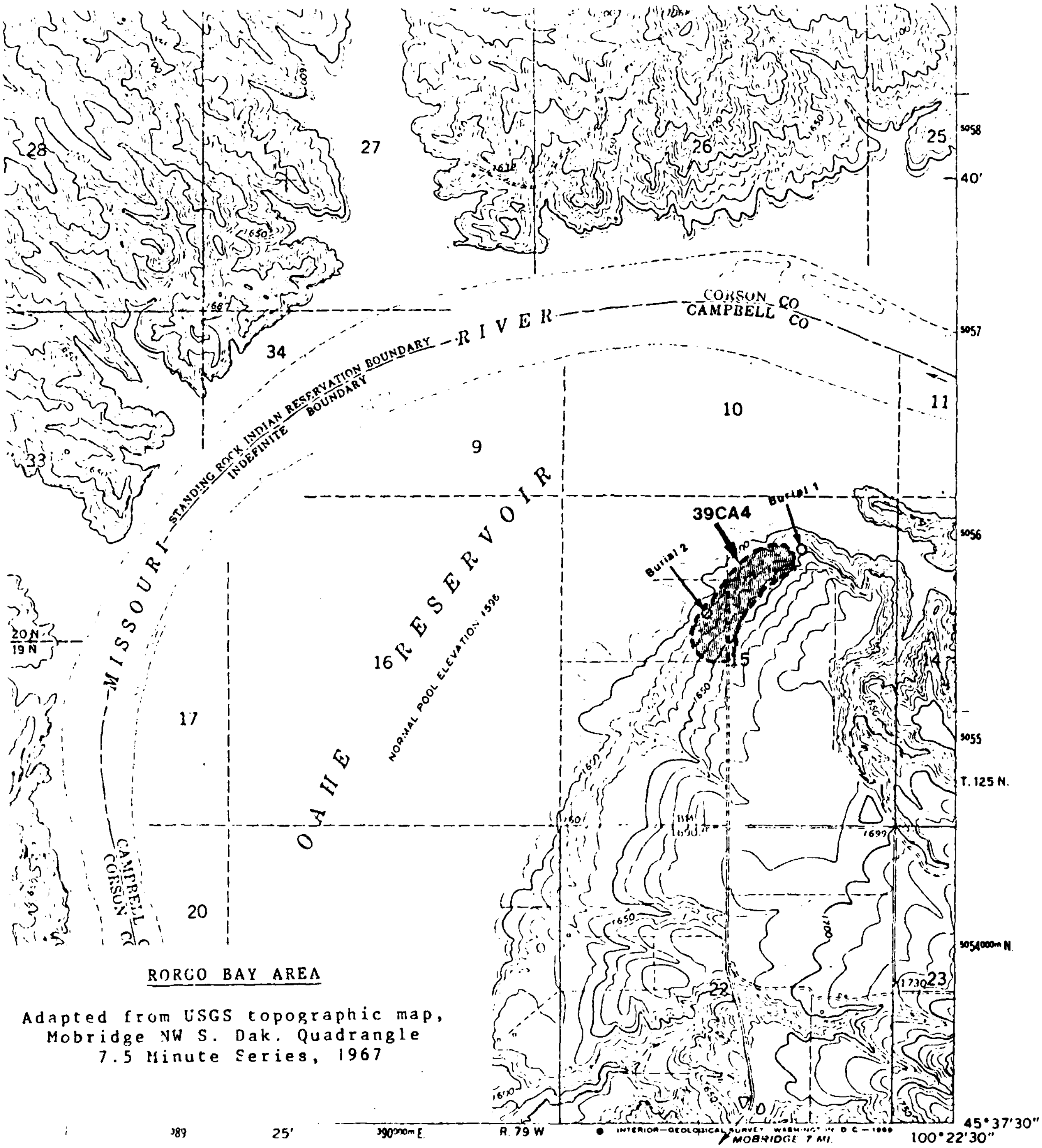


Figure 6. Burial locations, Anton Rygh site (39CA4).

cemetery has yielded nearly 600 burials (Bass et al. 1971). The majority of these were recovered by William Bass during the years 1957, 1958, 1961, and 1962 (Jantz 1972). The cemetery is divided into five areas (A through E) which include Extended Coalescent and Arikara associations (Owsley and Jantz 1978; Key 1983).

Two individuals are represented by the cranial remains recovered from the Sully site. Individual no. 1 consists of the cranium of an adult male (M_S=1.0) (Figure 7). Using enamel attrition an age of 30-35 years was determined. Although in a good state of preservation the spheno-occipital region of the cranial base is missing, an apparent postmortem cultural modification. A green stain is present at various locations on the surface of the cranium. Stains of this nature are commonly associated with copper ornamentation. However, organic algal staining is more likely. Individual no. 2 consists of an intact skull of an adult female (M_S=-0.8) (Figure 8). Like individual no. 1 the level of enamel attrition indicated an age of 30-35 years. Both crania are relatively broad and well rounded (CI=85.1 and 75.6 respectively), high vaulted (AMHI=74.3 and 72.9 respectively), and robust in appearance with well defined muscular markings such as the temporal line. The female skull also displays a distinct lambdoidal flattening, the probable result of artificial cranial deformation. Using Jantz's (1976:31) discriminant function the discriminant score (0.42) calculated for this skull falls on the Arikara side of the sectioning point.

4.5 Blue Blanket Recreation Area - Exhibit D, Catalogue No. 4

On April 2, 1985 two recreators discovered human skeletal remains eroding from the beach on a peninsula on the left bank of the Missouri River between Blue Blanket and Indian Creeks. They recovered the remains and contacted the Brown County Sheriff's office. The South Dakota Division of Criminal Investigation in turn contacted Mr. Timothy Nowak, Corps of Engineers field archaeologist (Lake 1985). These remains together with faunal elements (see Section 9.4) were then turned over to the Corps of Engineers.

The Blue Blanket Recreation Area is a beach access area of Lake Oahe in Walworth County five miles southeast of Mobridge, South Dakota. The skeletal remains were recovered directly adjacent to the Washboard Site (39WW47) (Figure 9). The Washboard site consists of lithic scatter present on the beach of this same small peninsula. No diagnostic materials have been recovered to assign this site to a specific cultural tradition (Weston et al. 1979). As previously discussed (see Section 4.2) this area along Lake Oahe near Mobridge is marked by several significant sites including Walth Bay (39WW203) (see Section 4.28) and the Larson site (39WW2). The Larson site is located approximately one mile south of Mobridge on the left bank of the Missouri river. The site consists of a fortified earthlodge village and cemetery. Over 700 burials were recovered from the cemetery whose interments are provisionally identified as Arikara (Jantz 1972).

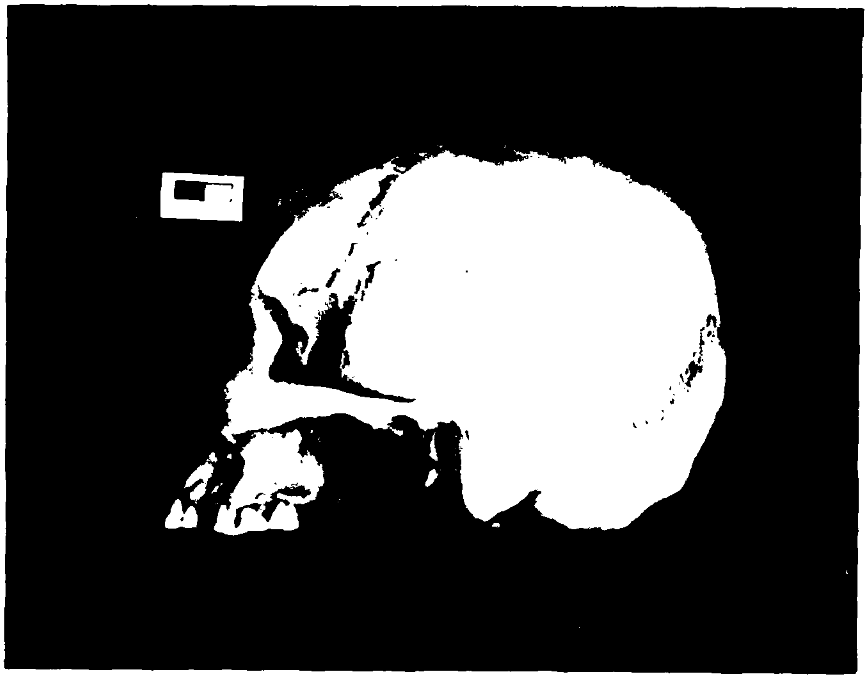
The human skeletal remains recovered from the Blue Blanket Recreation Area consist of a partial skeleton of an adult male (M_D=0.8, M_S=0.8), with a molar attrition age of 40-45 years. Approximately 50% of the skeleton is present

a.

b.

Figure 7. Cranium (individual no. 1) recovered from the Sully site (39SL4) (Exhibit C, Catalogue No. 3). a: frontal, b: left lateral.

a.



b.

Figure 8. Cranium (individual no. 2) recovered from the Sully site (39SL4) (Exhibit C, Catalogue No. 3). a: frontal, b: left lateral.

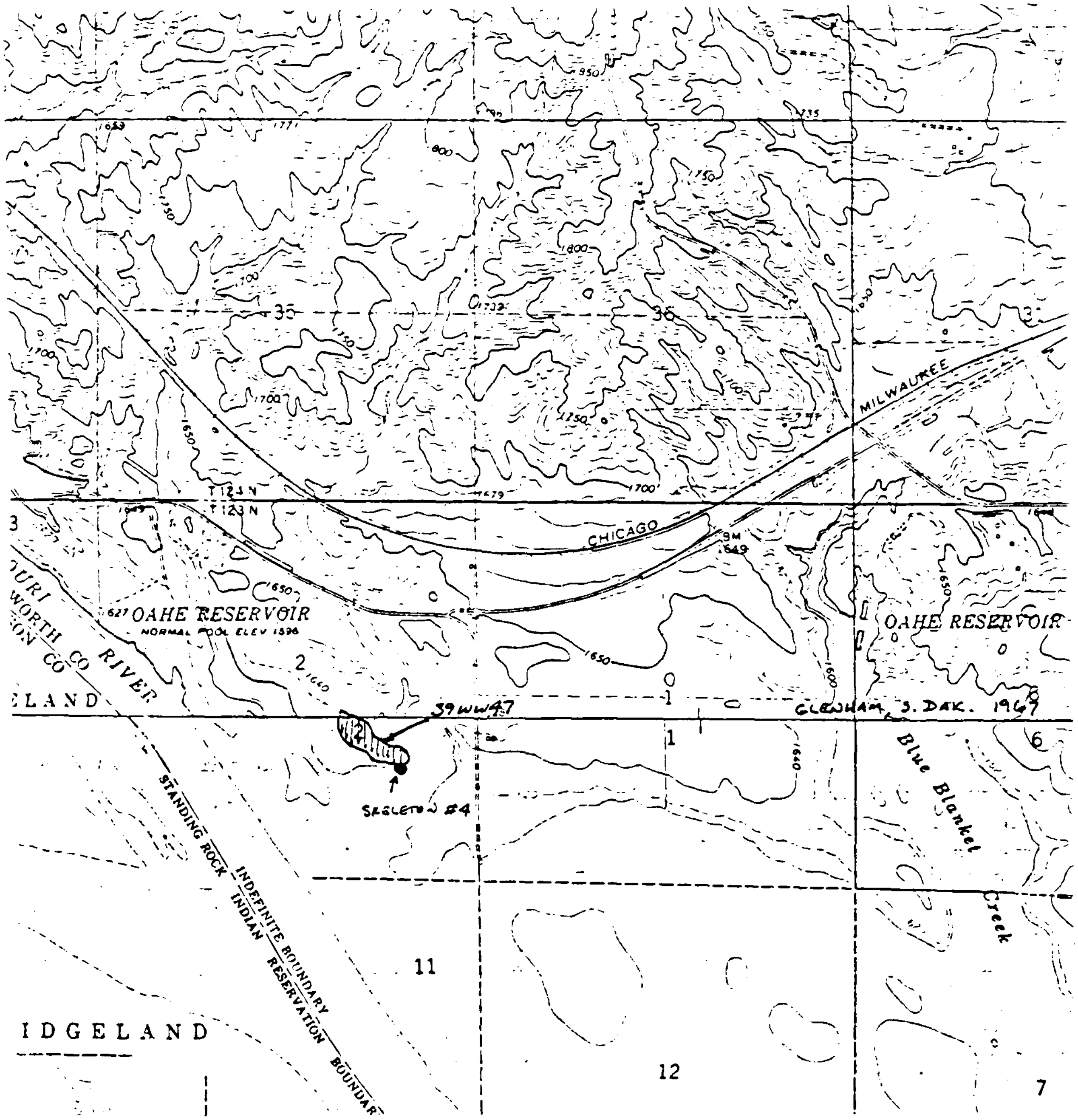


Figure 9. Location of burial recovered from the Blue Blanket Recreation Area.

including; the skull, the long bones, and portions of the thorax and vertebral column. The presence or absence of specific skeletal elements is probably related to the manner of recovery and not to differential interment. Although preservation is good the long bones display longitudinal splitting indicative of atmospheric and/or water exposure. A faint red ochre? stain is visible on the skull and infracranial elements. A green stain, most likely algal, is also present. The skull is rounded but average in shape (CI=75.6), very high vaulted (AMHI=75.7), and robust (Figure 10). The basilar occipital is missing, an apparent postmortem artifact. A slight lambdoidal flattening is evident on the skull, a possible result of artificial cranial deformation. Using Jantz's (1976:31) discriminant function, the discriminant score calculated (0.019) falls on the Mandan side of the sectioning point. In the absence of other culture-historic diagnostic features this cultural identification must remain tentative (see Sections 4.6, 4.10, 4.11, and 4.16).

4.6 Blue Blanket Recreation Area - Exhibit E, Catalogue No. 5

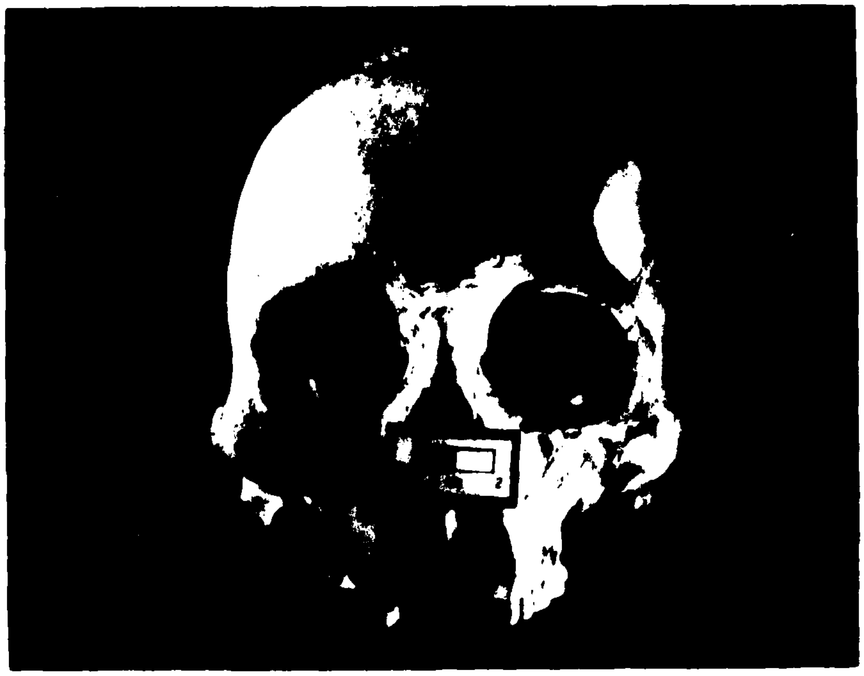
On March 24, 1984 a recreator and his family discovered human skeletal remains eroding out on the beach at the Blue Blanket Recreation area. Ignorant of the nature of what these remains were the recreator's son excavated the remains and proceeded to use some of the bones for firewood. As a result some of the remains are partially incinerated (Key 1985).

The skeletal remains were recovered near the Beehive site (39WW45) which is located on the same small peninsula as 39WW47 (see Section 4.5) (Figure 11). Like the Washboard site, the Beehive site also consists of lithic scatter on the exposed beach and lacks culturally diagnostic artifacts (Weston et al. 1979).

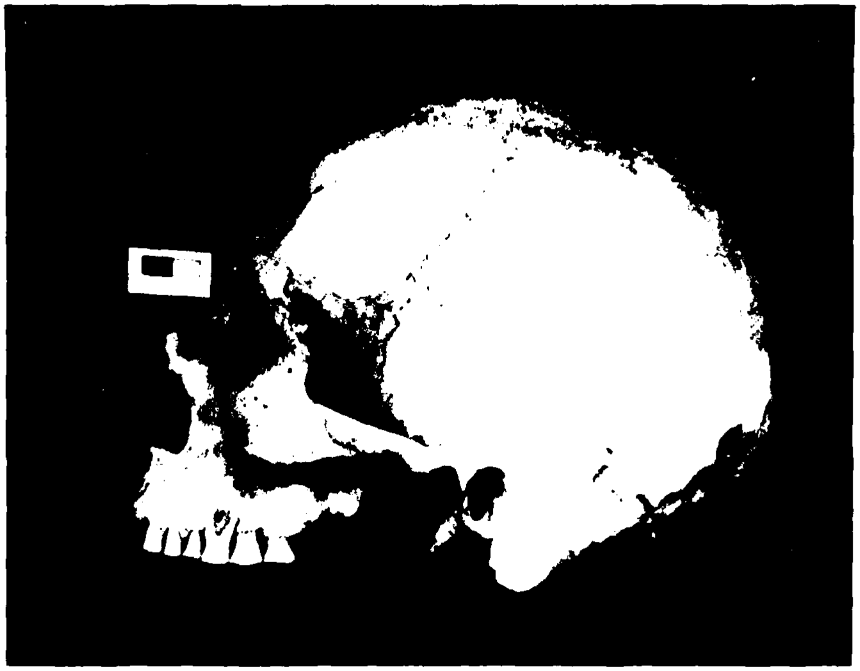
These remains consist of the partial skeleton of an adult male (M_p=0.9, M_s=1.2), with a pubic symphysis age of 23-39 years. Approximately 50% of the skeleton is present, including; the skull, fragmentary and intact longbones, both innominates, and the small bones of the hands and feet. Those remains not inadvertently damaged are well preserved. Both the skull and infracranial elements are robust and display hypermuscular traits such as an accentuated linea aspera and deltoid tuberosity. An ossified thyroid cartilage (Figure 12) is present and is unusual given the relatively young age of this individual (Krogman and Iscan 1986:128). The skull (Figure 13) is well rounded but average in shape (CI=77.6), and relatively high vaulted (AMHI=72.6). Using Jantz's (1976:31) discriminant function, the discriminant score (0.15) calculated for this skull falls on the Mandan side of the sectioning point. As with the other remains recovered from the Blue Blanket Recreation Area (see Sections 4.5, 4.10, 4.11, and 4.16), this cultural association must remain tentative.

4.7 Fort Thompson Area - Exhibit F, Catalogue No. 6

In late May of 1985 recreators discovered human skeletal remains along the Missouri River in the Fort Thompson area five miles south of the Big Bend Dam. According to Mr. Timothy Nowak, Corps of Engineers field archaeologist,



a.



b.

Figure 10. Cranium recovered from the Blue Blanket Recreation Area (Exhibit D, Catalogue No. 4). a: frontal, b: left lateral.

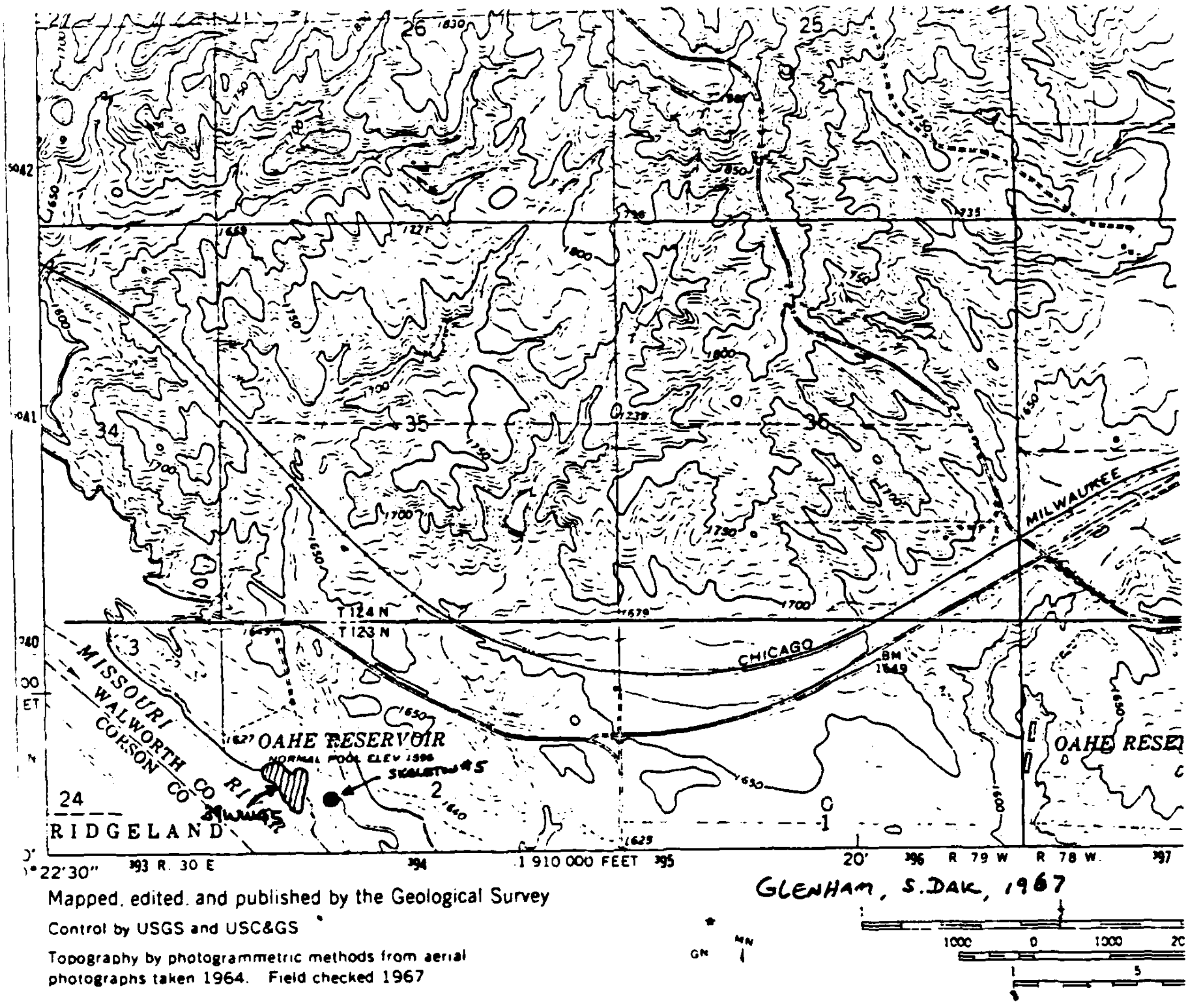


Figure 11. Location of burial recovered from the Blue Blanket Recreation Area.

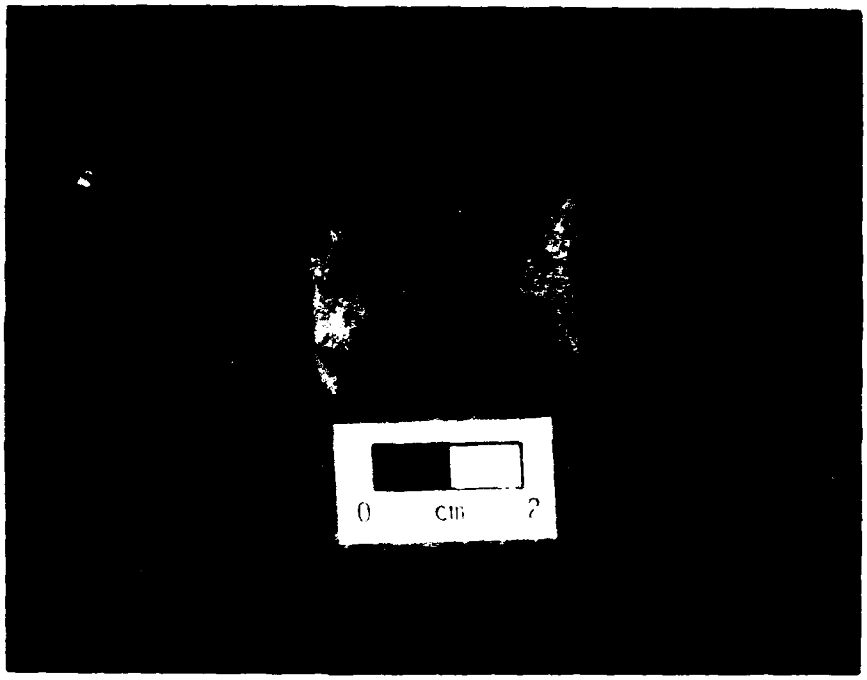


Figure 12. Ossified thyroid cartilage recovered with the human skeleton at the Blue Blanket Recreation Area (Exhibit E, Catalogue No. 5).

a.

b.

Figure 13. Cranium recovered from the Blue Blanket Recreation Area (Exhibit E, Catalogue No. 5). a: frontal, b: left lateral.

the skeletal remains were discovered near the Presbyterian Church Mounds (39BF235), but are not directly associated with this site. The Presbyterian Church Mounds site consists of two circular mounds that are part of the Fort Thompson Mound Group National Landmark. At the time of a 1979 survey the mounds were in good condition and not affected by erosion (Zimmerman and Emerson 1979:344).

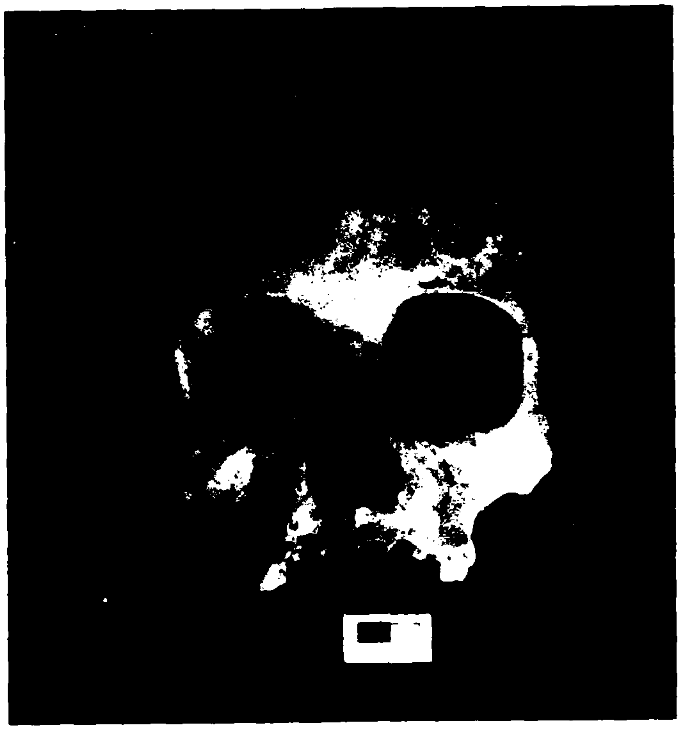
The Fort Thompson Mound Group consists of over 50 mounds in the Fort Thompson area (Huscher and McNutt 1958). Although many of these mounds were excavated during 1957-58, only the Truman Mound (39BF224) has been published (Neuman 1960). Also located in the Fort Thompson area of Lake Francis Case is the Talking Crow site (39BF3). The Talking Crow site is a multi-component earthlodge village, including both Woodland and historic Sioux occupations (Smith 1977). Five skeletons were recovered during the 1950-52 field seasons (Murrill 1977). One individual (Component III - Talking Crow Phase) was identified by Jantz (1977a) as Arikara showing closest similarity to a Sully site sample. Still farther south on the east bank of Lake Francis Case is the Crow Creek site (39BF11). This site is also a multi-component fortified earthlodge village and is located 10.5 miles north of Chamberlain, South Dakota. During the 1978 field season 486 Arikara skeletons were recovered from a fortification ditch at the site. The skeletons showed that the individuals had been massacred, and many had been mutilated (Willey 1982; Zimmerman et al. 1981).

A single partial juvenile skeleton is represented by the recovered remains. Approximately 30% of the skeleton is present and includes; the cranium, left humerus, left scapula, (2) vertebrae and ribs, and (2) metacarpals. The preservation of these remains is good. Long bone diaphysis length established an age of 8.0-8.5 years. Although juvenile, the cranium (Figure 14) is well rounded and broad in shape (CI=84.3), and high vaulted (AMHI=73.5), inconsistent with a Woodland age.

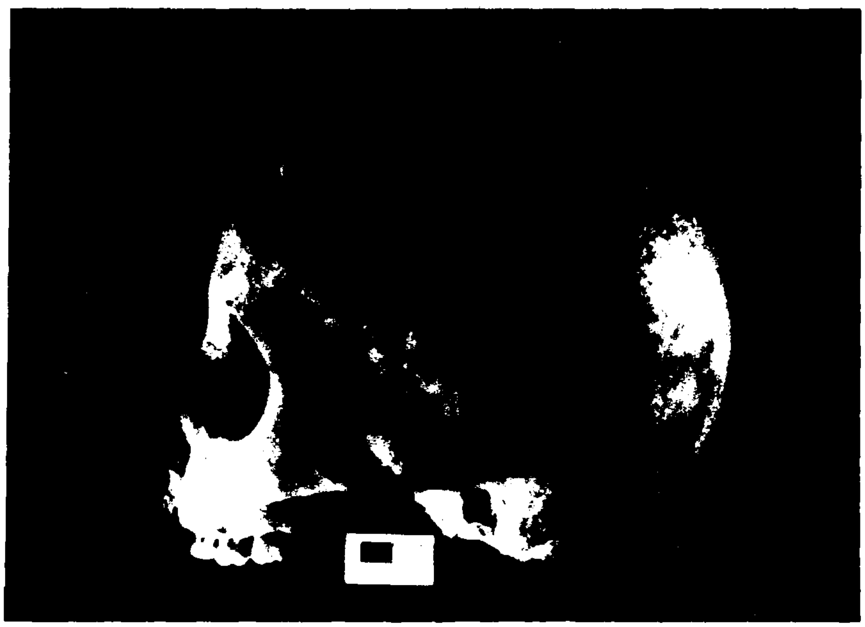
4.8 Mobridge Village (39WW1) - Exhibit G, Catalogue No. 7

On October 14, 1984 a resident of Mobridge, South Dakota discovered human skeletal remains eroding out of a cutbank just south of the Highway 12 bridge. He collected these together with faunal remains (see Section 9.5) and turned them over to the Corps of Engineers. According to Mr. Timothy Nowak, Corps of Engineers field archaeologist, the remains come from the approximate area of the cemetery associated with the Mobridge site (39WW1) (Henderson 1984a).

The Mobridge site is a protohistoric Arikara village and cemetery located on the east bank of the Missouri River just north of the city of Mobridge (Wedel 1955). This site, like others in the Mobridge area (see Sections 4.2 and 4.3), has a long excavation history. To date, three distinct burial areas, Features 1, 2, and 3, have been recognized. Forty individuals recovered by Stirling in 1923 have generally been regarded as belonging to Feature 1 (Wedel 1955:86). W.H. Over recovered 65 additional burials during the 1920s most of which came from Feature 2 (Sigstad and Sigstad 1973). Controlled systematic excavation by William Bass (1968-1970 field seasons) and by T. Dale Stewart and Douglas Ubelaker (1971 field season) included work at



a.



b.

Figure 14. Cranium recovered from the Fort Thompson area (Exhibit F, Catalogue No. 6). a: frontal, b: left lateral.

all three Features (Owsley 1981). In 1982 additional human skeletal remains were recovered from the Mobridge site after their discovery by a local resident (Rose et al. 1984). The location of the remains recovered in the two most recent cases does not correspond with any of the three previously identified Features and appears to indicate the presence of a fourth burial area (Timothy Nowak, personal communication, 1987).

Two individuals were identified from these remains. Individual no. 1 is an infant, age 0-0.5 years. This juvenile consists only of a fragmentary skull. The second individual is a multiparous female (M_p=-1.6) with a pubic symphysis age of 32-52 years (see Section 6.4). This individual is represented by approximately 60% of the skeleton, including; the long bones of both sets of appendages, ribs, the vertebrae of the lower spine, and portions of the hands and feet. Although the skull was not recovered, these remains are otherwise in a good state of preservation. Unfortunately, given the provenience of these burials it is impossible to determine whether there is any significance to their recovery together (i.e., mother and child).

4.9 Howes Site (39HU203) - Exhibit H, Catalogue No. 8

On August 14, 1984 the Corps of Engineers was notified by the South Dakota Department of Game, Fish, and Parks of an exposed burial at the Rousseau Recreation Area. Mr. Timothy Nowak inspected the site and recovered the partial skeleton of an adult from a cutbank near the mouth of the Medicine Knoll Creek at the Howes site (39HU203). The skeleton had been placed in a shallow basin-shaped pit. Instability of the bank forced a halt to the excavation so that the full extent of the burial is unknown (Henderson 1984b).

The Howes site is a multicomponent unfortified earthlodge village located on the east bank of the Missouri River along Lake Sharpe (Steinacher and Toom 1983). In addition to the Extended Coalescent earthlodge village, the site also contains the Historic Howes homestead. Directly adjacent to and south of the Howes site is the Rousseau site (39HU102) (Figure 15). The Rousseau site, like the Howes site is multicomponent. The four components identified range from Plains Archaic to Historic (Steinacher and Toom 1983).

The single adult male (M_p=1.9, M_s=1.2) recovered from the Howes site is in a poor state of preservation. Using the pubic symphysis and molar attrition an age of 30-39 years was determined for this individual. Approximately 50% of the skeleton is present, including; a damaged skull, most of the vertebral column and the upper appendages. No skeletal elements below the innominates were recovered. Both the cranial and infracranial remains display some evidence of atmospheric bleaching and weathering indicating that a significant interval of time had elapsed between exposure and discovery. Spotty red ochre stains are evident.

An uncorrected bone collagen radiocarbon date of 1260 $\pm$ B.P. (GX-13402) was obtained from this burial. The calibration of this date produced three possible corrections; 1225 B.P., 1215 B.P., and 1185 B.P., with a range from 1284 B.P. to 1069 B.P.. These dates would place these remains within the Woodland Period and well outside of the Extended Coalescent component of this

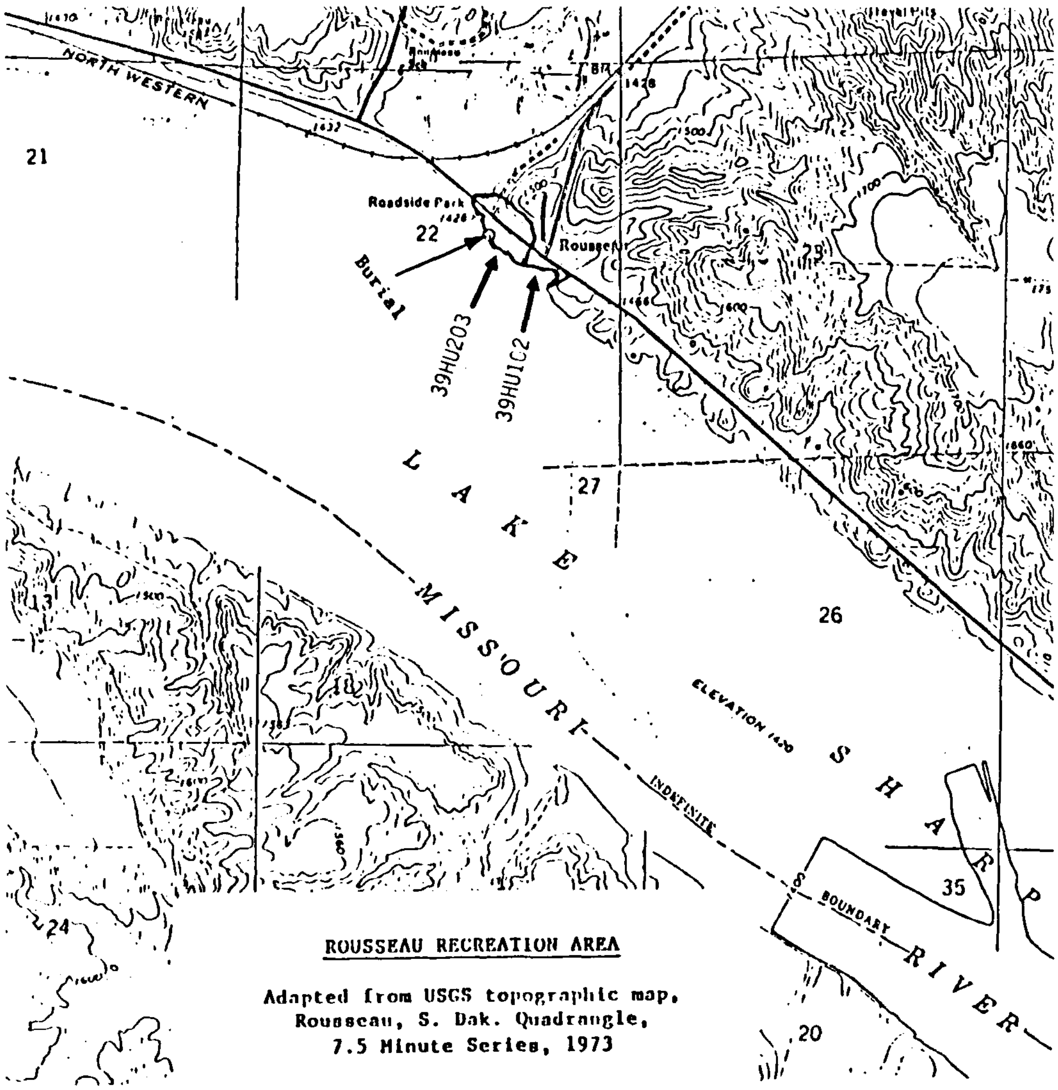


Figure 15. Location of the Howes site (39HU203).

site. The calvarium (Figure 16) is relatively long and narrow, similar in general form to Woodland and Middle Missouri crania. The skull, however, is too incomplete to ascertain or to quantify in any manner the culture-historic position of this burial. At the same time, the stable isotope concentrations fall within the values indicative of maize horticulture (see Section 7.2). Given the close proximity of this burial to the multicomponent Rousseau site the radiocarbon dates and cranial morphology are not inconsistent.

4.10 Blue Blanket Point (39WW98) - Exhibit I, Catalogue No. 9/10

On May 29, 1984 the Park Ranger of the Mobridge field office was notified by recreators that human bones were eroding out of a cutbank at the Blue Blanket Recreation Area. Mr. Timothy Nowak, Corps of Engineers field archaeologist, inspected the site and recovered three skulls and infracranial elements, as well as artifacts and faunal remains (see Sections 8.4 and 9.6). Evidence at the site indicated that the skeletal remains had been removed from the original burial pit (Kadlecek 1984). These remains together with others previously recovered (see Sections 4.11 and 4.16) were assigned by Nowak to a new site (39WW98) designated Blue Blanket Point. The Blue Blanket Point site is located on the northern-most tip of the small peninsula which contains the Blue Blanket Recreation Area (see Sections 4.5 and 4.6).

The commingled remains of five individuals (MNI=5) were recovered (Table 8). The preservation of these remains is fair to good, although many of the elements were moderately damaged. Although no complete skeletons were identified the presence of ribs, vertebrae, and tarsal elements suggests that at least one primary burial was present. Individual no. 1 is an infant, 0-1 years of age, represented by a fragmentary cranial and infracranial skeleton. Individual no. 2 is also a juvenile, with a diaphysis length age of 4.5-5.5 years, and is also represented by a partial fragmentary skeleton.

Individual no. 3 is a young adult female (M_p=-1.0). The sequence of epiphyseal union indicates an age of 17-23 years. Only a partial infracranial skeleton was recovered. The presence of infracranial elements in the process of epiphyseal union clearly segregates these remains from those of the two remaining adults. Although no skull was recovered, the presence of mildly worn incisors and a maxillary second molar consistent with the age of this female indicate that a skull was present at one time. Presumably it was lost to either erosion or pothunting.

Individual no. 4 consists of the partial skeleton of an older adult female (M_p=-1.3, M_s=-1.2), with a combined pubic symphysis and molar attrition age of 40-47 years. The innominates of this female display multiparous pitting (see Section 6.10). The skull is rounded but narrow (CI=73.4), low vaulted (AMHI=71.1), and robust (Figure 17). Using Jantz's (1976) discriminant function, the discriminant score calculated (0.606) falls on the Mandan side of the sectioning point.

Individual no. 5 is an adult male (M_p=1.7, M_s=1.3), age 50+ years. The infracranial elements of this partial skeleton are hyperrobust with well defined muscle insertions. The mandible recovered is nearly edentulous.

a.

b.

Figure 16. Calvarium recovered from the Howes site (39HU203) (Exhibit H, Catalogue No. 8). a: superior, b: left lateral.

Table 8. Individuals recovered from Blue Blanket Point (39WW98).

Indiv.	Age	Sex	% Recovered	Elements Recovered
1	0-1	na	5%	fragmentary l. humerus, fragmentary l. & r. femora, distal r
2	4.5-5.5	na	15%	fragmentary skull(i-5), fragmentary r. tibia, r. femur, fragmentary clavicle, fragmentary r. ulna, fragmentary fibul
3	17-23	female	35%	l. & r. clavicles(i-152/153), l. & r. humeri(i-42/46), l. & r scapulae(i-11/13), l. & r. innominates(i-19/20), l. & r. tib (i-50/51), l. & r. fibulae(i-30/32)
4	40-47	female	50%	skull(i-1/4), l. & r. scapulae(i-9/10), l. & r. humeri(i-44/4 l. & r. ulnae(i-33/41), r. radius(i-35), l. & r. innominates (i-7/17), l. & r. femora(i-55/56), l. & r. tibiae(i-49/52), l. & r. fibulae(i-36/39)
5	50+	male	45%	skull(i-2/3), l. & r. scapulae(i-12/14), l. & r. humeri(i-43/ l. & r. radii(i-38/54), l. & r. ulnae(i-33/41), l. & r. innominates(i-16/18), l. & r. femora(i-53/57), l. & r. tibiae (i-47/58), r. fibula(i-31)

Although the face is missing the calvarium is rounded but narrow (CI=71.5), and very low vaulted (AMHI=67.3) (Figure 18). Although the skull is incomplete the morphology of the calvarium, especially the low vault height, is incompatible with a Coalescent or Arikara association (Jantz and Willey 1983; Owsley and Symes 1981).

A number of adult infracranial elements, including ribs, vertebrae, and tarsal bones could not be associated with certainty with any of the three adult skeletons. The distribution of these elements is consistent with the number of adults present, however.

The artifacts recovered with these burials were undiagnostic although there is some suggestion of a pre-Coalescent age (see Section 8.4). In the absence of other diagnostic features this cultural association must remain tentative (see Sections 4.5, 4.6, 4.11).

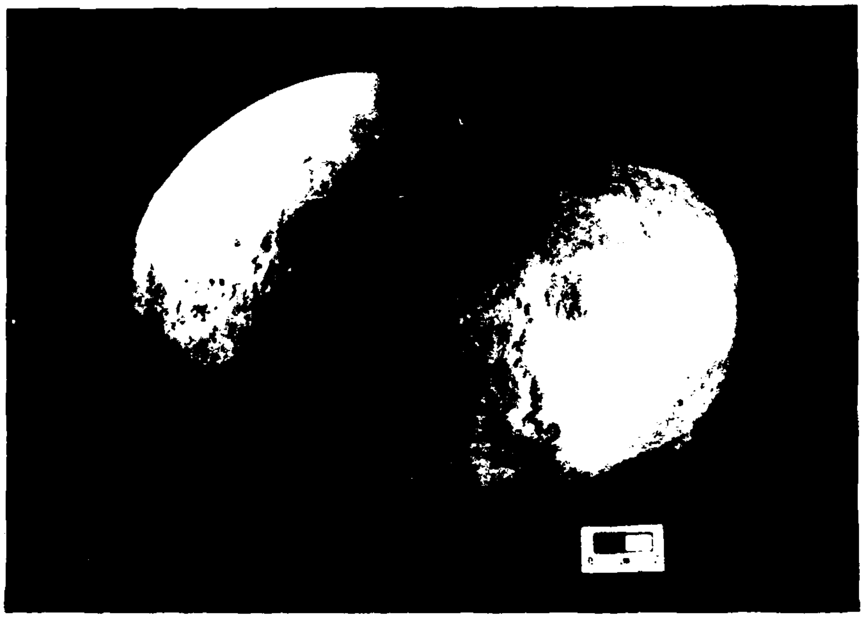
4.11 Blue Blanket Point (39WW98) - Exhibit J, Catalogue no. 11

On August 17, 1983 Mr. Timothy Nowak, Corps of Engineers field archaeologist recovered a partial skeleton from an exposed cutbank at the Blue Blanket Recreation Area at the Blue Blanket Point site (39WW98) (see Sections

a.

b.

Figure 17. Cranium (individual no. 4) recovered from Blue Blanket Point (39WW98) (Exhibit I, Catalogue No. 9/10). a: frontal, b: left lateral.



a.

b.

Figure 18. Cranium (individual no. 5) recovered from Blue Blanket Point (39WW98) (Exhibit I, Catalogue No. 9/10). a: superior, b: left lateral.

4.10 and 4.16). The skeleton appears to have been interred as a bundle burial wrapped in cedar bark cloth (Kadlecek 1984).

A single juvenile, with an age of 12 years based on epiphyseal union, is represented by approximately 40% of the skeleton. The remains are in a fair state of preservation displaying some evidence of atmospheric weathering. A damaged skull (Figure 19), lacking most of the facial skeleton, is present together with various infracranial elements of the thorax and upper appendages.

4.12 Pike Haven Recreation Area - Exhibit K, Catalogue No. 12

The manager of the Pike Haven Resort near the Pike Haven Recreation Area along the east bank Lake Oahe in Sully County turned over to the Corps of Engineers a single adult cranium. The nearest recorded site to the approximate location of the recovered skull is 39SL310, a historic standing log cabin.

The recovered cranium is that of a young adult female (M_S=-1.1). The sequence of dental eruption, the relative absence of appreciable molar attrition, and an unfused basilar suture give this cranium an age of approximately 17 years (Figure 20) Although intact, it is badly weathered by atmospheric and/or water exposure. The cranial vault is well rounded and broad (CI=80.2), but low vaulted (AMHI=69). It is also very gracile in appearance. However, this is most likely a reflection of the relatively young age of this individual. In the absence of diagnostic artifacts, this combination of features makes it difficult to place in a culture-historic framework. However, the lack of Euro-American characteristics makes it unlikely to have any association with site 39SL310.

4.13 Donahue Site (39LM27) - Exhibit L, Catalogue No. 13

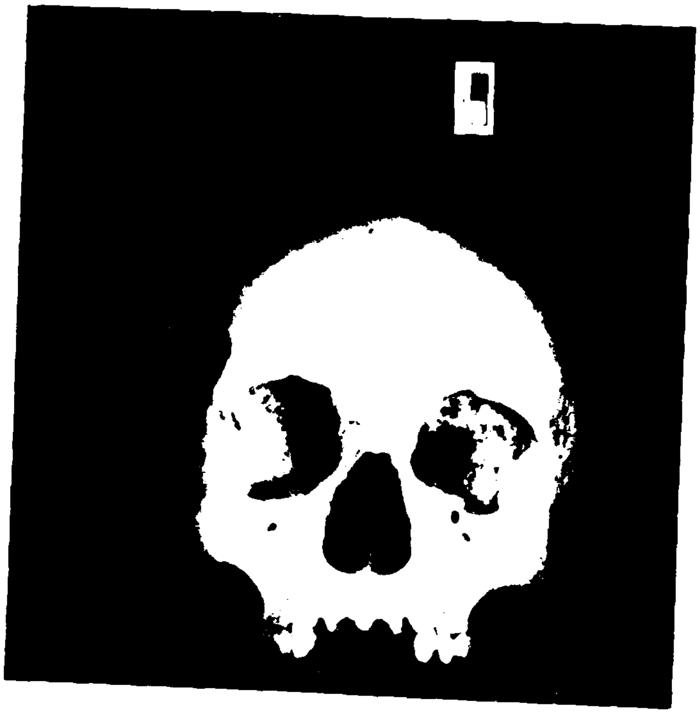
On July 17-18, 1985 Mr. Timothy Nowak, Corps of Engineers field archaeologist, inspected the Donahue site (39LM27) together with three other sites impacted by wave erosion (Figure 21). During the inspection he recovered from the site fragmentary cranial remains (Nowak 1985b).

The Donahue site, also known as Oacoma Village II, is an apparent multicomponent earthlodge village with both Woodland and Post-Contact Coalescent components (Lehmer 1971; Winham and Lueck 1984). The site is located on the right bank of the Missouri River along Lake Francis Case south of the City of Chamberlain, South Dakota. Directly east of the Donahue site is the Sharpe or Oacoma Village I site (39LM26) which also includes the same Woodland and Post-Contact Coalescent components. Both sites are usually referred to in the literature together, and have a long excavation history. During the 1920s W. H. Over visited the site at which time 50 skeletons were removed (Sigstad and Sigstad 1973). Both sites were later excavated as part of the Smithsonian Institution, River Basin Surveys and by the Nebraska State Historical Society in conjunction with the National Park Service (Winham and Lueck 1984). During the latter excavation by M. F. Kivett (1952) a single

a.

b.

Figure 1[illegible]. Cranium recovered from Blue Blanket Point (39WW98) (Exhibit [illegible], Catalogue No. 11[illegible]. a: superior, b: left lateral.



a.

b.

Figure 20.. Cranium recovered from the Pike Haven Recreation Area (Exhibit K, Catalogue No. 12). a: frontal, b: left lateral.

burial was recovered. In 1980 additional human skeletal remains of nine individuals were recovered by the U. S. Army Corps of Engineers (Rose et al. 1984). These remains, as well as those recovered by W. H. Over, display multiple cutmarks indicative of dissection and/or mutilation (Douglas Owsley, personal communication 1987).

The very fragmentary cranial remains of three individuals (MNI=3) were recovered. All three consist of small portions of the calvarium. The crania are poorly preserved and display evidence of extensive atmospheric and/or water degradation in the form of bleaching and splitting. A green algal(?) stain is present on the external as well as internal surfaces of the cranial fragments. Although these crania were fragmentary no evidence of cut marks or other butchering/dissection activity was observed.

Segregation of these remains into three discernable individuals was based on the multiple presence of the same cranial bones. Individual no. 1 is represented by the posterior calvarium. The occipital bone is completely fused indicating an age in excess of 8 years (Krogman and Iscan 1986:110). The size, thickness and overall appearance of this cranial fragment suggests an age of approximately 16 years. Individual no. 2 consists of the left and right parietals and the frontal. The metopic suture is fused. This together with the size and thickness of the bones suggests a juvenile/young adult of 8+ years. Individual no. 3 is represented by the left and right parietals. The general appearance of these bones suggests an age of +10 years. All three show little evidence of suture closure. However, beyond this no precise age or sex can be assigned to these remains.

4.14 Brush Creek Area - Exhibit M, Catalogue No. 14

Sometime during 1986 the manager of the Pike Haven Resort reported to the Corps of Engineers the discovery of exposed human remains at the Brush Creek area of Lake Oahe. These were collected by the Oahe Park Manager. The approximate location of these remains is a small peninsula at the confluence of the Cheyenne and Missouri Rivers with Brush Creek on the west bank of Lake Oahe in the extreme northeast corner of Stanley County. No other provenience is available.

This area of Lake Oahe which separates the Grand-Moreau and Bad-Cheyenne regions is marked by a relatively dense concentration of both historic and prehistoric sites (Winham and Lueck 1987). The majority of these sites are now inundated by Lake Oahe. Historic sites include the St. John's Mission for Girls, the Episcopal Boys School, and three Lewis and Clark expedition campsites. Prehistoric sites in close proximity to the approximate location of the Brush Creek locale include the Cheyenne River Village (39ST1), the Myers site (39ST10) and a mound group (39ST48). The Cheyenne River Village is a multicomponent fortified earthlodge village that was located just below the mouth of the Cheyenne River. Components include Extended Middle Missouri, Extended Coalescent, and Post-Contact Coalescent (Cooper and Stephenson 1953; Lehmer 1971). W. H. Over excavated the site in 1921 and removed the skeletal remains of eight individuals (Sigstad and Sigstad 1973). The site was also excavated during the 1955-56 field seasons by Waldo Wedel as part of the

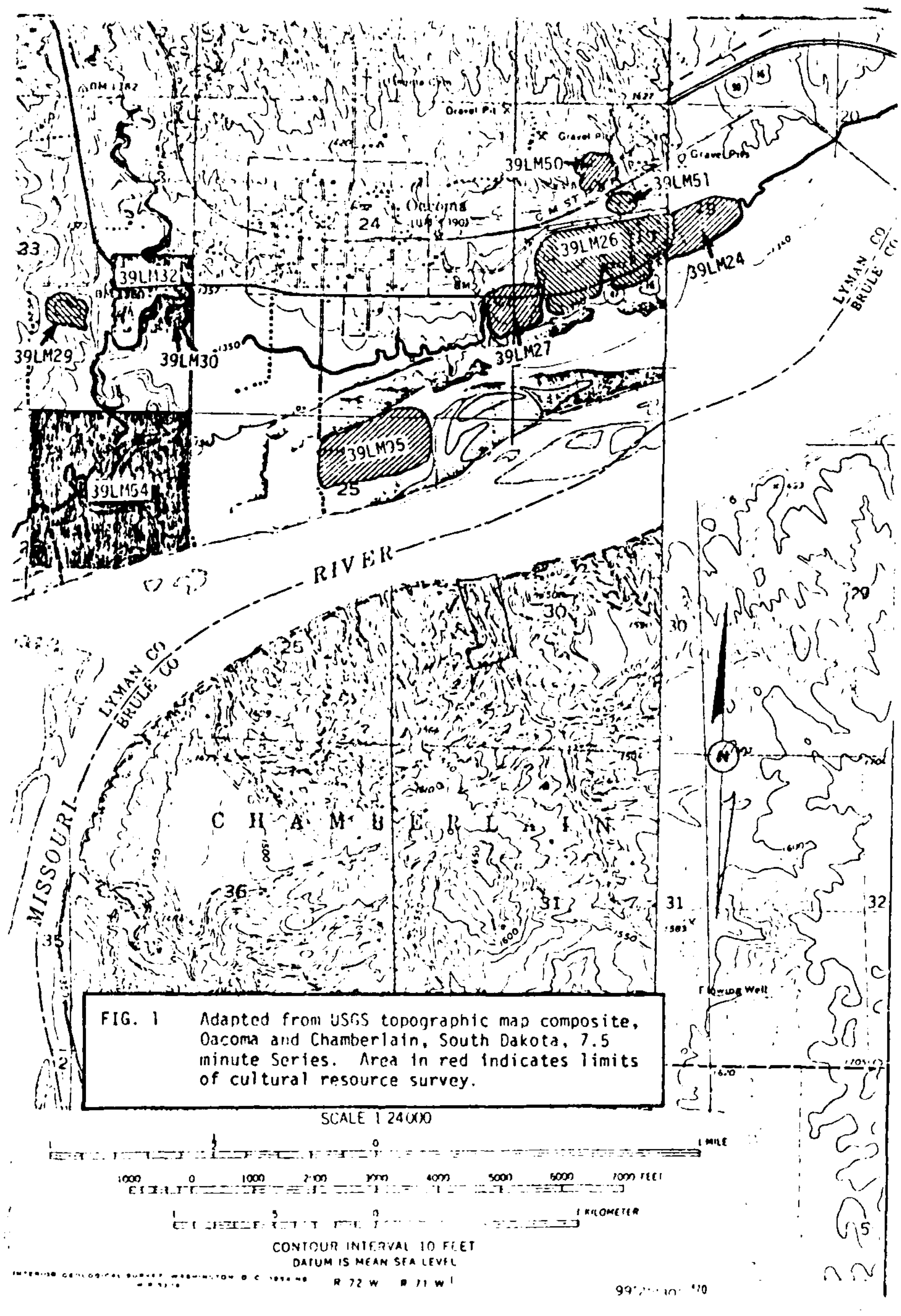


FIG. 1 Adapted from USGS topographic map composite, Oacoma and Chamberlain, South Dakota, 7.5 minute Series. Area in red indicates limits of cultural resource survey.

Figure 21. Location of the Donahue site (39LM27).

Smithsonian Institution River Basin Surveys (Lehmer 1971). At this time additional burials were recovered which Jantz (1972) suggests are most likely Arikara. The Myers site is an Extended Coalescent earthlodge village directly south of the Cheyenne Village site (Cooper and Stephenson 1953:60). Site 39ST48 is a mound group of unknown temporal or cultural placement located south of the Myers site (Cooper and Stephenson 1953; Winham and Lueck 1987).

The remains collected at the Brush Creek area consist of the partial skeleton of an adult female (M_p=-0.8, M_s=-0.5). The degree of degenerative joint disease (see Section 6.14) suggests an age of ca 50 years. Approximately 60% of the skeleton is present, primarily the long bones and the skull. Some atmospheric weathering in the form of bleaching is evident. The skull (Figure 22) is well rounded and short. It also displays some evidence of lambdoidal flattening, probable artificial cranial deformation. Although the calvarium has a Coalescent appearance the absence of the face and cranial base makes further quantification of these remains difficult.

4.15 Elm Creek Recreation Area - Exhibit N, Catalogue No. 15

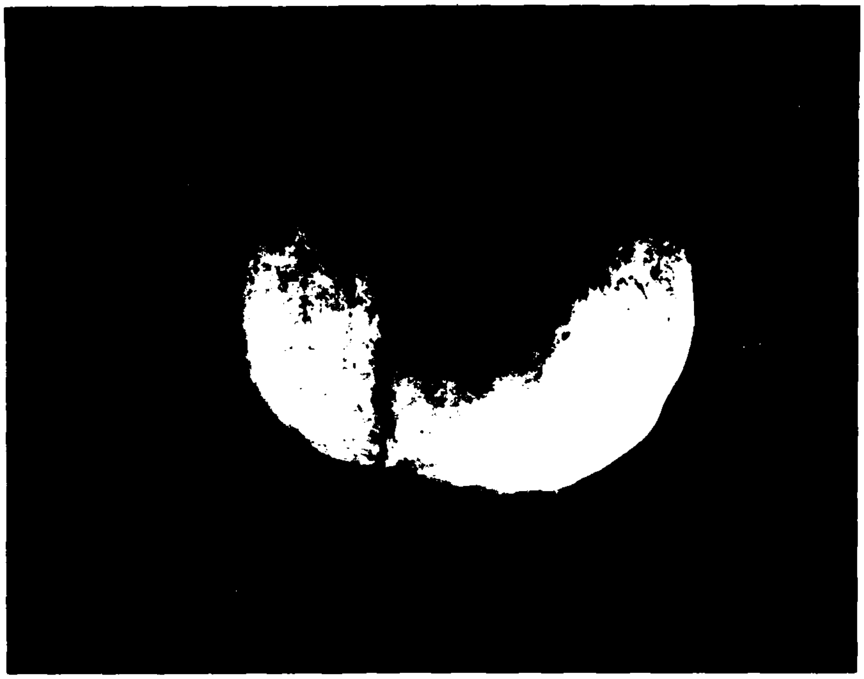
Sometime during 1986 Corps of Engineers park rangers collected miscellaneous human and faunal remains (see Section 9.7) from the Elm Creek Recreation Area along Lake Francis Case on the east bank of the Missouri River approximately 20 miles south of Chamberlain, South Dakota. Although provenience is unknown the remains are possibly associated with site 39BR22.

Site 39BR22 is one of several archaeological sites recorded at the Elm Creek Recreation Area. This site has both historic and prehistoric components but of unknown temporal and cultural identity (Zimmerman and Emerson 1979:192). In close proximity to this site, although now inundated by the waters of Lake Francis Case, is the Elm Creek site (39BR9). This village/campsite was tested as part of the Smithsonian Institution, River Basin Surveys and contains possible burials (Zimmerman and Emerson 1979:174). Site 39BR102 is also located at the Elm Creek Recreation area and is of possible Late Woodland age (Zimmerman and Emerson 1979).

The commingled remains of three individuals (MNI=3) were recovered. Individual no. 1 is a juvenile, with a diaphysis age of 6-7 years, represented by a right radius, a fibula, and left and right tibiae. Individuals no. 2 and 3 are adults of unknown age. They are represented by various infracranial elements of the lower appendicular skeleton, including; a left and right femur, an intact and fragmentary right tibia, and a left tibia and fibula. Although more than one individual was present (i.e., two right tibiae) no further segregation or association of these remains was possible.

4.16 Blue Blanket Point (39WW98) - Exhibit O, Catalogue No. 16

On July 13, 1983 a recreator discovered human skeletal remains eroding from a cutbank at the Blue Blanket Recreation Area at the Blue Blanket Point site (39WW98). The recreator exposed the burial which was later recovered by a Corps of Engineers park technician. On August 17, 1983 Mr. Timothy Nowak,



a.

b.

Figure 22. Calvarium recovered from the Brush Creek area (Exhibit N, Catalogue No. 14). a: superior, b:left lateral.

Corps of Engineers field archaeologist, inspected the site and recovered additional skeletal remains from the site (see Sections 4.10 and 4.11) (Kadlecek 1984).

A juvenile, with an age of 11-12 years based on dental development and eruption, is represented by a partial fragmentary skeleton. No intact infracranial elements were recovered except for the small bones of the hands and feet. While the skeleton is fairly complete (60%), the lower appendicular skeleton is underrepresented. Some atmospheric weathering in the form of bleaching was observed. This, together with the manner of recovery and the poor preservation of the remains may explain the absence of particular skeletal elements. The skull although juvenile and incomplete (Figure 23) is on the narrow side of an average or mesocranic shape (CI=76.0).

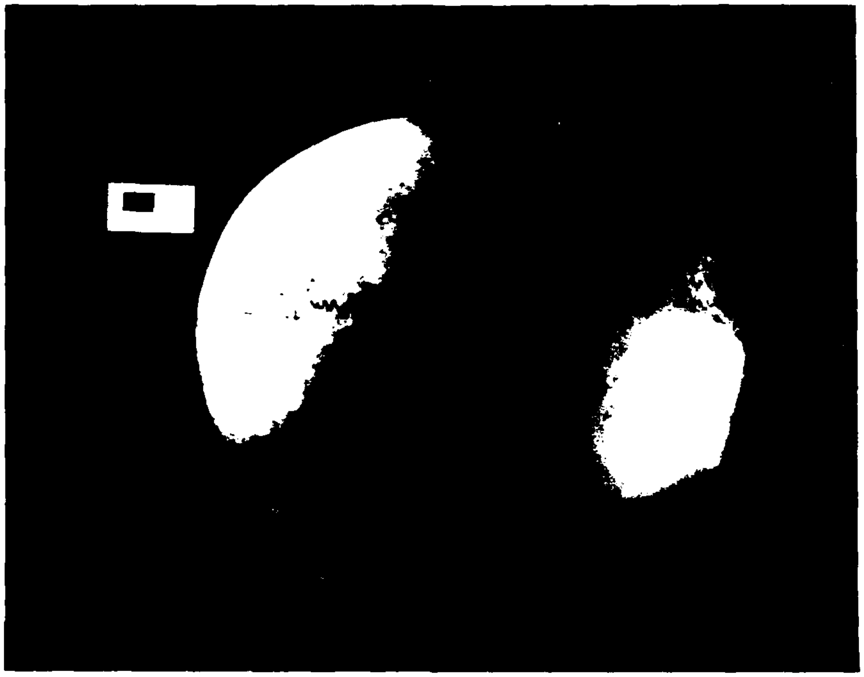
The artifacts recovered from this site (see Section 8.5), like those discussed previously (see Section 4.10) point to a pre-Coalescent age for these skeletal remains. Including those remains recovered from the Blue Blanket Recreation Area (4.5 and 4.6) a total of nine individuals were identified for this site and the surrounding area. Those crania that were intact were consistently classified as Mandan, or Middle Missouri, when using Jantz's discriminant function. The artifacts recovered support this affiliation.

When using any discriminant function there always exists a chance of misclassification due to the closed nature of the statistic. Any skull in this particular circumstance, will be classified as either Mandan or Arikara. As Jantz (1976:32, 1977b), Jantz and Willey (1983), and Owsley and Symes (1981) have demonstrated, auricular height is one of several features which differentiate Mandan from Arikara crania. The crania recovered from Blue Blanket Point and the Blue Blanket Recreation Area are relatively low vaulted. This is also a characteristic of Woodland and Middle Missouri crania (Jantz and Willey 1983:63). It is highly probable that this site is of Woodland or Middle Missouri age. However, in the absence of other indicators of culture-historic position the correct interpretation of these collections of artifacts and skeletal remains cannot be known with any degree of assurance.

4.17 Okobojo Point - Exhibit P, Catalogue No. 17

During the spring of 1983 a recreator observed a burial eroding from a cutbank at Okobojo Point at the Okobojo Recreation Area of Lake Oahe. The recreator collected the skeletal remains along with some artifacts and turned them over to Mr. Timothy Nowak, the Corps of Engineers field archaeologist. Nowak inspected the site and recovered additional remains, artifacts, and faunal remains (see Sections 8.6 and 9.8). The burial recovered appears to have been interred in a rock lined pit (Church 1985).

During recent improvements made at the Okobojo Recreation Area, test excavations and monitoring of four sites (39SL295, 39SL297, 39SL298, 39SL318) were conducted. These four had previously been identified and mapped by the University of Nebraska in 1979 (Church 1985). All four sites are



a.

b.

Figure 23. Juvenile cranium recovered from Blue Blanket Point (39WW98)(Exhibit 0, Catalogue No. 16). a: superior, b: right lateral.

characterized by lithic scatter but lack diagnostic artifacts. The previously identified burial area which is adjacent to site 39SL297 (Figure 24) was also monitored at this time but no additional burials were discovered.

Two juveniles were identified from the recovered remains (MNI=2). Individual no. 1, with a diaphysis length age of 6-7 years, is represented by a fragmentary but nearly complete skeleton (80%). The skull, although recovered, was not intact. Slight red ochre stains were present on the cranial elements. Individual no. 2 is represented by a partial infracranial skeleton (60%); fragmentary left humerus, left and right femora, left and right tibiae. Based on the length of the diaphyses this individual was determined to be 0-0.5 years of age. The artifacts, which include 85 perforated teeth (see Section 8.6), cannot place these remains in a cultural-historical position other than the observation that due to poor preservation they may be more than 200-300 years old.

4.18 LeCompte Catholic Cemetery - Exhibit Q, Catalogue No. 18

On June 21, 1986 the Mobridge Police Department notified the Park Ranger at Lake Oahe of exposed human skeletal remains and a coffin near L Compte Creek. in the southeast corner of Corson County. The remains were collected and turned over the Corps of Engineers. Mr. Timothy Nowak, Corps of Engineers South Dakota field archaeologist, inspected the site but no additional remains were recovered (Nowak 1986).

The LeCompte Catholic Cemetery was located on the grounds of the LeCompte Catholic Church of the Diocese of Rapid City, South Dakota. The cemetery saw use from 1894 to 1952. A total of 70 graves were located of which 66 were identified (Corps of Engineers Cemetery Relocation File). Under the Cemetery Relocation Plan Stage IV all 70 individuals were disinterred in 1962 and reinterred in other local cemeteries (Nowak 1986).

A right innominate and the pubis of a left innominate were recovered from the coffin. These pelvic remains are from a female (M_p=-1.6), age 22-40 years of age. Blood stains and organic matter are still present on the external surface of the remains suggesting a relatively recent interment. Unfortunately, the cemetery records are incomplete as to the age and sex of many of the burials. Also it is unclear how much of this cemetery has already undergone erosion damage. It is impossible therefore to identify who these remains are associated with.

4.19 Prairie Dog Bay - Exhibit R, Catalogue No. 19

On or about April 4, 1983 a recreator discovered human remains exposed along the shoreline of Prairie Dog Bay at the North Point Recreation Area on the east bank of Lake Francis Case in Charles Mix County. These remains were recovered by the recreator and later were turned over to the Corps of Engineers.

Although no site was identified, the location of these remains (NW¼ NE¼ SW¼

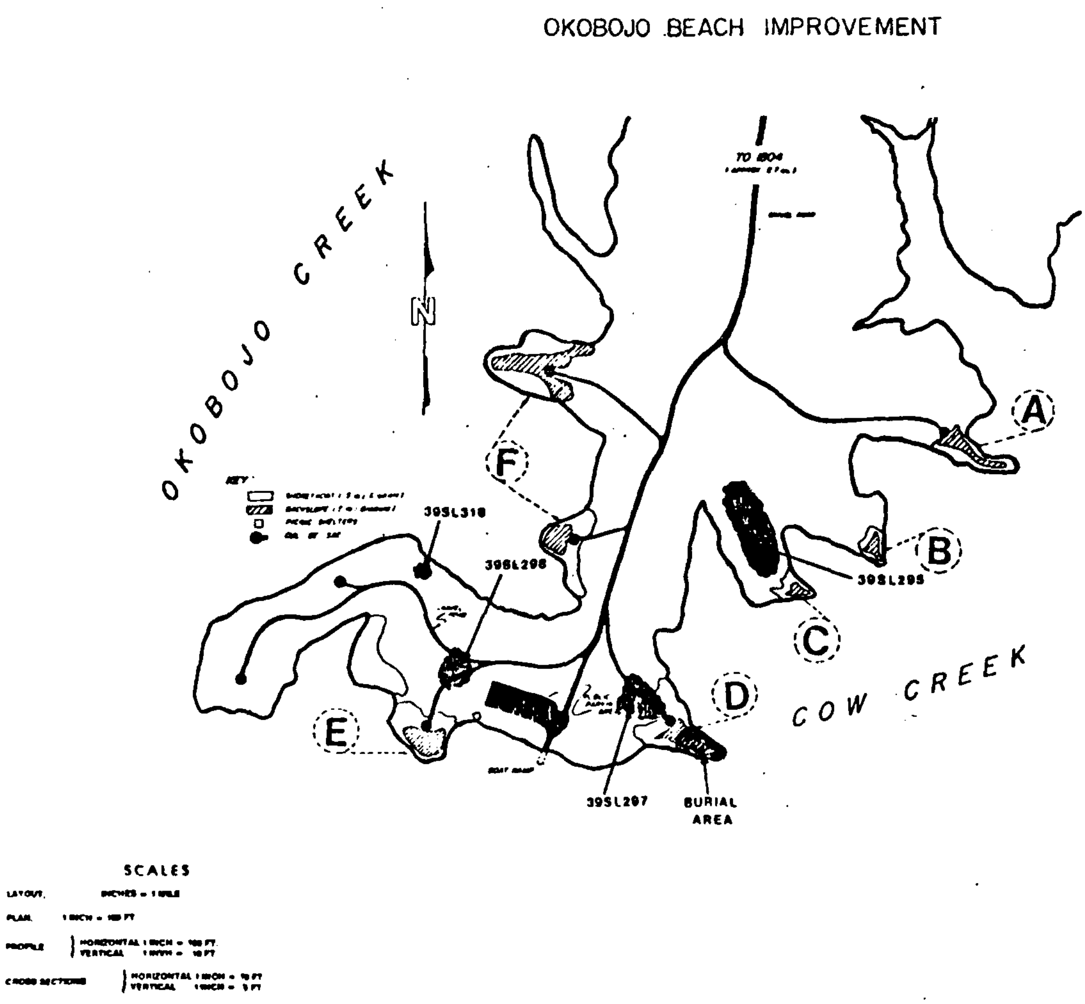


Figure 24. Location of the burial recovered from Okobojo Point, from Church (1985).

NW¼, Sec. 5, T95N, R65W) places them in close proximity to several recorded sites; 39CH10, 39CH11, 39CH13, 39CH16, and 39CH17 (Zimmerman and Emerson 1979). Two of these sites (39CH11 and 39CH13) are associated with a historic Yankton occupation. The latter site is thought to have included a burial area (Zimmerman and Emerson 1979:69). Both sites, however, were either inundated by Lake Francis Case or destroyed by the construction of the Fort Randall Dam. Approximately 3/4 of mile northwest of this location is the Sunrise Hill site (39CH210) (see Section 4.27).

A single adult of unknown age (+23 years) is represented by left and right femora and tibiae. These remains are heavily weathered by atmospheric and/or water exposure. No further description is possible.

4.20 39LM59 - Exhibit S, Catalogue No. 20A

On July 19, 1983 an archaeological survey conducted by the Center for Western Studies at Augustana College discovered human skeletal remains eroding out of a cutbank along the west bank of Lake Francis case at site 39LM59. At the direction of Mr. Timothy Nowak, Corps of Engineers field archaeologist, the survey crew removed slumped bone and excavated those remains that were accessible in the cutbank (Winham 1983). At least two primary burials, laid side by side, were present, interred in a bell-shaped pit.

Site 39LM59 is an Initial Middle Missouri village site located in Lyman County directly south of site 39LM57 (see Sections 4.21 and 4.23) (Figure 25). The burials and associated artifacts recovered from this site appear to be located within the occupation area (Winham and Lueck 1984:106).

At least two individuals (MNI=2) appear to be represented by these burials, designated lower front burial [LFB] and lower rear burial [LRB]. Individual no. 1 (LFB) is the partial infracranial skeleton of an adult multiparous female (M_p=-1.5) (see Section 6.18), with a pubic symphysis age of 32-52 years. This individual is represented by six thoracic vertebrae (s-49,s-54-58), four lumbar vertebrae (s-50-53), fragmentary sacrum (s-60), left clavicle (s-75), fragmentary left scapula (s-81/82), fragmentary left ulna (s-2), left radius (s-74), left and right innominates (s-1, s-47), and (4) metacarpals (s-76-79). Individual no. 2 (LRB) consists of the partial infracranial skeleton of an adult female (M_p=-1.1), with a pubic symphysis age of 52-59 years. This individual is represented by two cervical vertebrae (s-12/13), one thoracic vertebra (s-11), a sternum (s-10/31), and a left innominate (s-3). Additional fragments, ribs and phalanges were unassignable but were consistent with the presence of two adults. Both individuals were poorly preserved and displayed a green algal(?) stain. A red ochre stain was present on individual no. 2.

Two overlapping radiocarbon dates were obtained for these burials. The first came from a charcoal sample recovered from the burial pit, which yielded an uncorrected date of 1135 ± 95 B.P. (GX-13398). The second date was obtained from a combined bone collagen sample from both individuals. This sample produced an uncorrected date of 1170 ± 75 years B.P. (GX-13403). The corrected dates respectively were 1058 B.P. (1170 - 950 B.P.) and 1067 B.P.

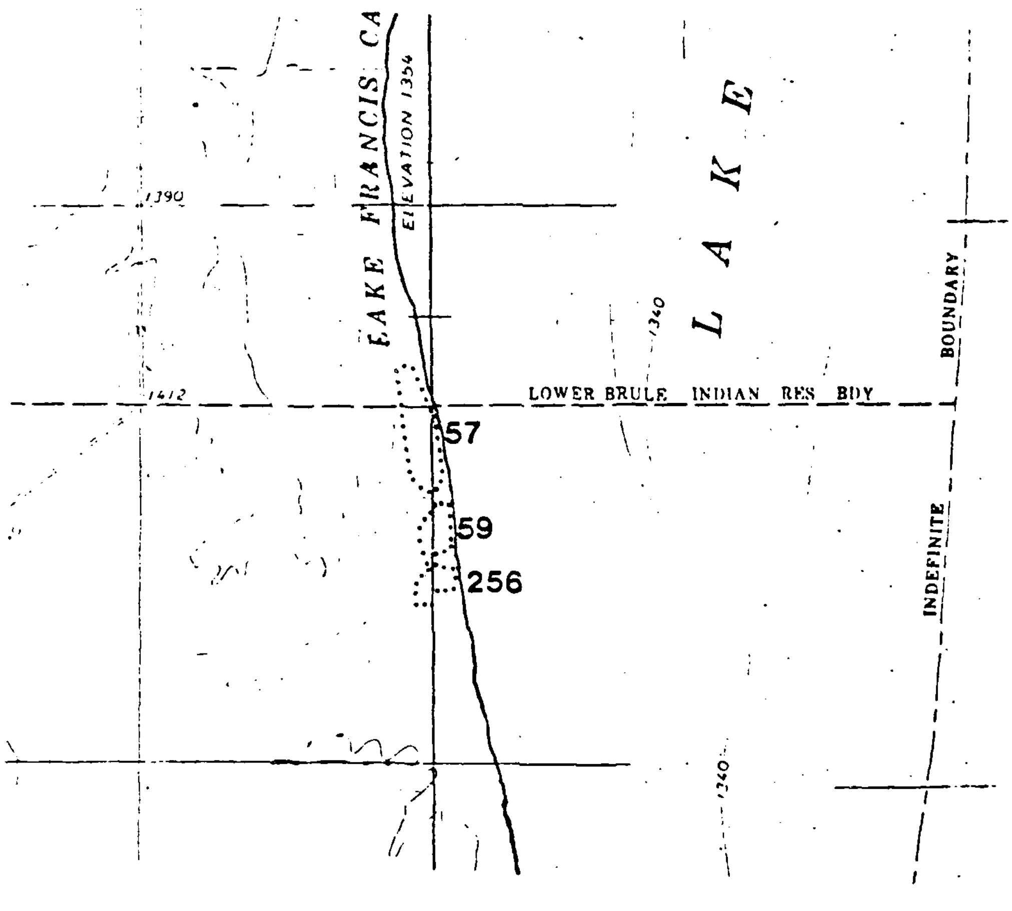


Figure 25. Location of sites 39LM57, 39LM59, and 39LM256 (adapted from Winham and Lueck 1984).

(1200 - 1093 B.P.). While these dates are consistent with the Initial Middle Missouri component identified for this site they do not preclude the association of these burials with site 39LM57, which has both Woodland and Initial Middle Missouri components. The artifacts recovered (see Section 8.7), although few in number and probably inadvertently included in the burial fill, also support the Initial Middle Missouri identification of these burials.

4.21 Fort Lookout II (39LM57) - Exhibit T, Catalogue No. 20B

On July 19, 1983 an archaeological survey conducted by the Center for Western Studies at Augustana College discovered human skeletal remains eroding out of a cutbank along the west bank of Lake Francis Case at the Fort Lookout II site (39LM57). At the direction of Mr. Timothy Nowak, Corps of Engineers field archaeologist, the survey crew removed slumped human and animal bone (see Section 9.9) and excavated those remains that were accessible in the cutbank (Winham 1983).

The Fort Lookout II site is a multicomponent occupation site which includes Woodland, Initial Middle Missouri, and historic components. An early historic reservation and army post (1856-1857) are included among the historic components (Miller 1953; Winham and Lueck 1984). The site is located in Lyman County approximately 8 miles north of Oacoma, South Dakota straddling the boundary of the Lower Brule Indian Reservation (see Sections 4.20 and 4.23) (Figure 25).

The fragmentary cranial remains of three individuals (MNI=3) were recovered. Individual no. 1 is an adult female (M_S=-2.0), age +45 years, and is represented by a damaged mandible (t-5) and maxilla (t-8). Individual no. 2 is a juvenile consisting of a left frontal. The size of this cranial fragment together with an unfused metopic suture indicates an age of 1-3 years. Individual no. 3 consists of a fragmentary mandible (t-6) and isolated teeth of an adult, with a molar attrition age of 20-25 years. An intact right femur and several cranial fragments were unassignable to either adult. A green algal(?) stain is present on the femur.

The right femur was used to obtain a single uncorrected bone collagen radiocarbon date of 1080 $\pm$ 75 B.P. (GX-13404). The calibrated date of 976 B.P. (1064 - 932 B.P.) places this burial just within the Initial Middle Missouri. Unfortunately, the cranial remains are too fragmentary to provide further clarification of the age or the culture-historic position of this burial.

4.22 Scalp Creek Cemetery (39GR32) - Exhibit U, Catalogue No. 21

On July 23, 1983 an archaeological survey conducted by the Office of Archaeological Research, Museum of Anthropology, University of Kansas, discovered human skeletal remains eroding from a cutbank along the west bank of Lake Francis Case at the confluence of Scalp Creek and the Missouri River (Lees et al. 1985). These remains were recovered from a burial area

apparently associated with the now inundated Scalp Creek Site (39GR1).

The Scalp Creek Cemetery site (39GR32) is located in Gregory County approximately 6 miles northwest of the Fort Randall Dam. Although the cemetery is of unknown cultural affinity it is located in close proximity to two recorded sites, the Scalp Creek site (39GR1) and the Ellis Creek site (39GR2) (Lees et al. 1985). The Scalp Creek site is a multicomponent (Woodland and possible Extended Coalescent) fortified earthlodge village which lies 760 meters north of the location of the Scalp Creek Cemetery. The W. H. Over Museum excavated the site in 1941 and recovered six burials from a small mound within the village (Hurt 1952:22). In 1951 Wesley Hurt Jr. excavated the site and recovered three additional burials. Although Hurt suggests that the original six burials are associated with the Woodland component this has not been supported by later analysis (Key 1983:135). The Ellis Creek site is a Woodland village which is located approximately 2.2 miles south of the Scalp Creek site.

At least two individuals (MNI=2) are represented by the very fragmentary remains recovered from two test pits made at the burial site. Individual no. 1 is a juvenile/young adult, possibly female, ca 15 years of age. This individual was recovered from test pit #1 and is represented by a fragmentary skull and fragmentary right humerus. The humerus displays an apparently unfused distal epiphysis. The highly fragmentary nature and poor preservation of these remains makes this difficult to positively ascertain. However, the size of this bone together with the relative level of cranial suture closure present on the cranial fragments is consistent with this age. The second individual, recovered from test pit #2, is a possible adult male, and consists of a fragmentary left femur. Cranial fragments were also recovered from test pit #2. The very fragmentary nature of these remains made it impossible to determine whether they were associated with either individual. No further analysis was possible.

4.23 39LM256 - Exhibit V, Catalogue No. 22

On July 19, 1983 an archaeological survey conducted by the Center for Western Studies at Augustana College discovered human skeletal remains eroding out of a cutbank along the west bank of Lake Francis Case at site 39LM256. At the direction of Mr. Timothy Nowak, Corps of Engineers field archaeologist, the survey crew removed slumped bone and excavated those remains that were accessible in the cutbank (Winham 1983). The remains of several individuals, primarily skulls, together with artifacts and faunal remains (see Sections 8.8 and 9.10), were recovered from a bell-shaped pit. Because of the danger of the bank collapsing, complete exhumation was not attempted.

Site 39LM256 is an occupation and burial site with historic (ca 1890-1920) and unknown prehistoric components (Winham and Lueck 1984). The site is located adjacent to and directly south of site 39LM59 (see Sections 4.20 and 4.21) (Figure 25).

Seven crania (skulls A-G) and commingled infracranial remains were recovered from the burial pit. Although the crania were damaged, the

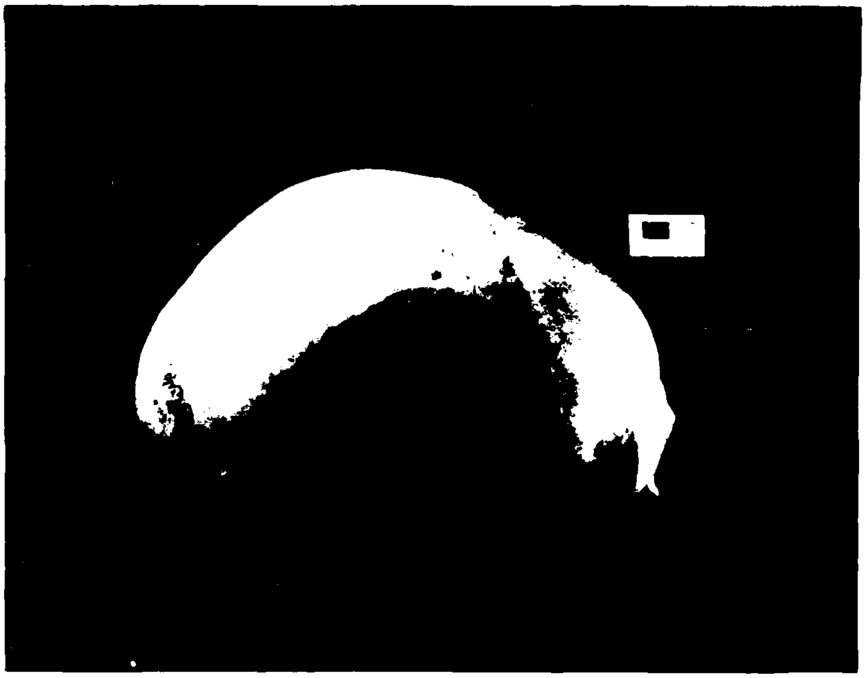
preservation of these burials was otherwise fair to good. A right femur (v-4) displayed two parallel incisions or cut marks on the head inferior to the fovea capitis, the apparent result of dissection (Figure 26).

Using the crania a total of seven individuals (MNI=7) were identified (Table 9). Individual no. 1 is represented by the damaged skull of an adult male (M_S=0.7), with a molar attrition age of 40-45 years (Figure 27). Endocranial suture closure is complete. The mandible recovered with skull F appears associated with this cranium. The second individual is a juvenile consisting of a fragmentary cranium. The presence of a fused metopic suture and unfused basilar occipital indicates an age of between 4-6 years. Individual no. 3 is also a juvenile and is also represented by a fragmentary cranium. The presence of a fused metopic suture and partially fused cervical vertebrae (complete neural arch without body union) corresponds with an age of 2-3 years. Individual no. 4 is a juvenile, age 0.5-1.5 years, and consists only of a left frontal bone without metopic suture closure. Individual no. 5 is an adult female (M_S=-0.8), with a molar attrition age of 40-45 years. The maxilla and mandible of this skull are heavily damaged. The sixth individual (skull F) consists of a fragmentary partial cranium of an adult female (M_S=-0.7), with a molar attrition age of 30-35 years. The mandible recovered with this skull is nearly edentulous and does not match the fragmentary maxilla. The seventh individual consists of a fragmentary skull of an adult male (M_S=0.6). A pair of left and right male (M_p=1.7) innominates with a pubic symphysis age of 23-37 years appear to be associated with this individual. However, it is also possible that these innominates are associated with individual no. 1.

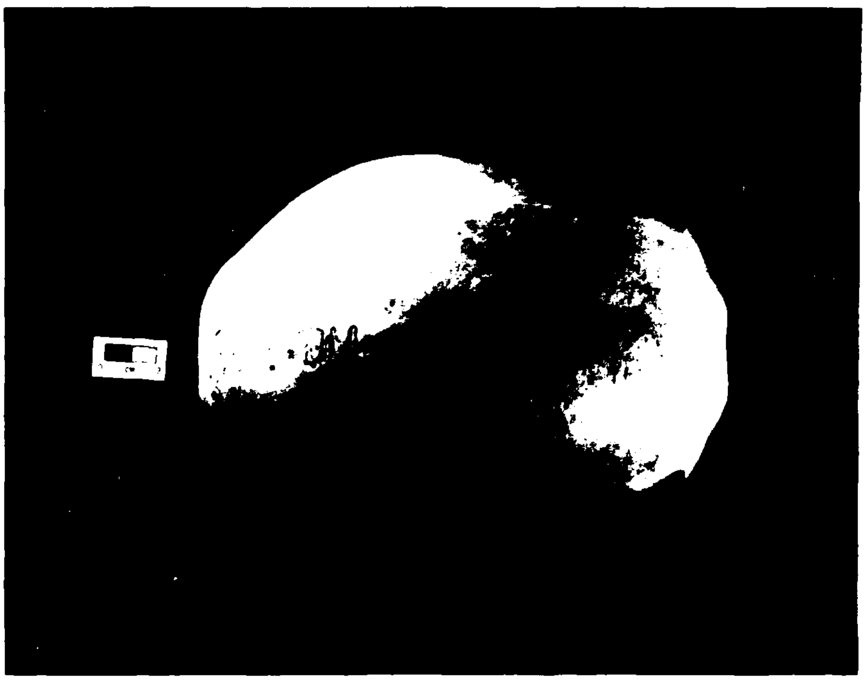
All four adult crania display a yellow/green stain which is also present on various infracranial elements. This appears to be yellow ochre although an algal stain cannot be ruled out. The majority of the infracranial elements display postmortem damage similar to that seen at the Jamestown Mounds Site (32SN22) (Williams 1985a). This pattern of damage involves varying levels of disintegration resulting in crystalline-like fragmentation, mimicking incineration. This damage at the Jamestown Mounds Site was attributed to gypsum impregnation. This highly soluble mineral readily enters bone. When water levels drop crystallization occurs. With repeated impregnation and crystallization, the bone disintegrates. Given the location of this burial such a scenario is not improbable. However, without further investigation of the soil matrix the true nature of this damage remains unknown.

Isolated infracranial remains include seven adult femora, four of which could be paired with some certainty (v-3/v-9 and v-1/v-4). The remaining femora include two left shafts. Also present were a pair of tibiae (v-5/v-7), two left scapulae (v-57 & v-58), left and right distal humeri (V-12 & v-14), a pair of radii (v-15/v-17), a proximal left ulna (v-13), and distal left and right ulnae (v-24 and v-23). Based on the number of femora present, the infracranial remains represent a minimum of four adults (MNI=4). This is consistent with the number of adult crania. Three juvenile infracranial elements, a right ulna (v-29), a left ilium (v-30), and a right tibia (v-27), based on their size, appear to be associated with individual no. 4. No further associations between the cranial and infracranial elements were possible.

Figure 26. Cut marks on the head of a right femur (v-4) recovered from [illegible]256 (Exhibit V, Catalogue No. 22).



a.



b.

Figure 27. Damaged cranium (skull A, individual no. 1) recovered from 39LM256 (Exhibit V, Catalogue No. 22). a: right lateral, b: superior.

Table 9. Individuals recovered from 39LM256.

Individual	Skull	Age	Sex
1	A	40-45	male
2	B	4-6	na
3	C	2-3	na
4	D	0-1.5	na
5	E	40-45	female
6	F	30-35	female
7	G	23-37	male

While the infracranial remains appear to have been commingled prior to recovery, the salvage report makes no mention of their in-situ disposition (Winham 1983; Winham and Lueck 1984).

Three radiocarbon samples were obtained from the bone collagen of three femora. The first femur produced an uncorrected date of 1725 ± 120 B.P. (GX-13405-1). The calibration of this date produced three possible corrections, 1687 B.P., 1673 B.P., and 1620 B.P. (1726 - 1542 B.P.). The second femur produced an uncorrected date of 1620 ± 80 B.P. (GX-13405-2). The corrected date of 1530 B.P. (1553-1388 B.P.), although almost a hundred years younger than the first radiocarbon date, overlaps its standard deviation. The third femur produced an uncorrected radiocarbon date of 1170 ± 60 B.P. (SMU 1945). The corrected date of 1067 B.P. (1170-1020 B.P.) is 368 years younger than the latest of the first two dates. While this still places all three dates in a Middle to Late Woodland temporal context, the lack of congruity in radiocarbon dates is problematic. In support of these radiocarbon dates are the $\delta^{13}C$'s. All three are in agreement and indicate a pre-maize horticulture diet (see Section 7.2). Added to this is the apparent bell-shaped burial pit, a feature inconsistent with a Woodland age. If this is indeed a Woodland cemetery, it would not be unusual to find multiple interment episodes spanning several centuries (Snortland-Coles n.d.; Williams 1982a, 1985c). Unfortunately, the methods used for the recovery of these remains makes it impossible to reconstruct interment circumstances.

The artifacts recovered from the burial pit (see Section 8.8) do not provide any further indication of the culture-historic position of these burials. Given the close proximity of site 39LM256 to Fort Lookout II and to 39LM59 the burials recovered may not be directly associated with the site. Fort Lookout II does contain a Woodland component. However, the prehistoric component of site 39LM256 has yet to be defined.

4.24 39ST126 - Exhibit W, Catalogue No. 23

On July 11, 1983 an archaeological survey conducted by the University of North Dakota discovered a human skeleton eroding from a ravine 183 meters west of the Stony Point site (39ST235) on the west bank of Lake Sharpe approximately 8 miles southeast of Fort Pierre (Figure 28). A primary flexed burial together with artifacts was recovered by the survey crew from a bell shaped pit. The burial site has been designated 39ST126 (Toom and Picha 1984).

The Stony Point site (39ST235) is a multicomponent earthlodge village containing Initial Middle Missouri and Post-Contact Coalescent components Steinacher 1981; Toom et al. 1979). W. H. Over excavated the site during the early part of this century during which time he recovered nine burials from a burial area south of the site (Sigstad and Sigstad 1973).

The poorly preserved skeleton of an adult female (M_p=-1.2), with a pubic symphysis age of 44-54 years, was recovered. This nearly complete skeleton (90%) was lacking only the very small bones of the hands and feet. However, the external surfaces of the cranial and infracranial elements were heavily eroded. As a result very little data could be derived from this skeleton.

A single uncorrected bone collagen radiocarbon date of 295 ± 75 B.P. (GX-13406) was obtained despite the poor preservation. The corrected date, 312 B.P. (473 - 288 B.P.) places these remains within the Extended/Post-Contact Coalescent. The artifacts recovered with this burial (see Section 8.9), which consist only of limonite concretions, provide no evidence of the culture-historic position of this burial. Assuming that this burial is indeed associated with Stony Point (39ST235), the radiocarbon date is consistent with the Post-Contact Coalescent component of this site. In the absence of further information, either osteological or artifactual, no further discussion is possible concerning this cemetery site.

4.25 39BR13 - Exhibit X, Catalogue No. 25

Human skeletal remains were recovered by a park ranger from the beach area directly adjacent to site 39BR13 along the east bank of Lake Francis Case approximately 4 miles north of Chamberlain, South Dakota.

Site 39BR13 is a multicomponent village site located in the Brule Bottom area of the Missouri River (Figure 29). Components include Initial Middle Missouri, Initial Coalescent, and possible Post-Contact Coalescent (Zimmerman and Emerson 1979; Tibesar et al. 1986). To the west of this site, separated by a draw is the Swanson site (39BR16). The Swanson site is a fortified Initial Middle Missouri village. No burials have previously been recorded at either site. Also located in the Brule Bottom area north of the Swanson site is the Brule Flat Village (39BR10) (see Section 4.30).

The very partial infracranial skeletons of two adult females were recovered. Individual no. 1 is a female (M_p=-1.4) of undetermined age (+23 years) and is represented by a right innominate (x-13) and a right radius

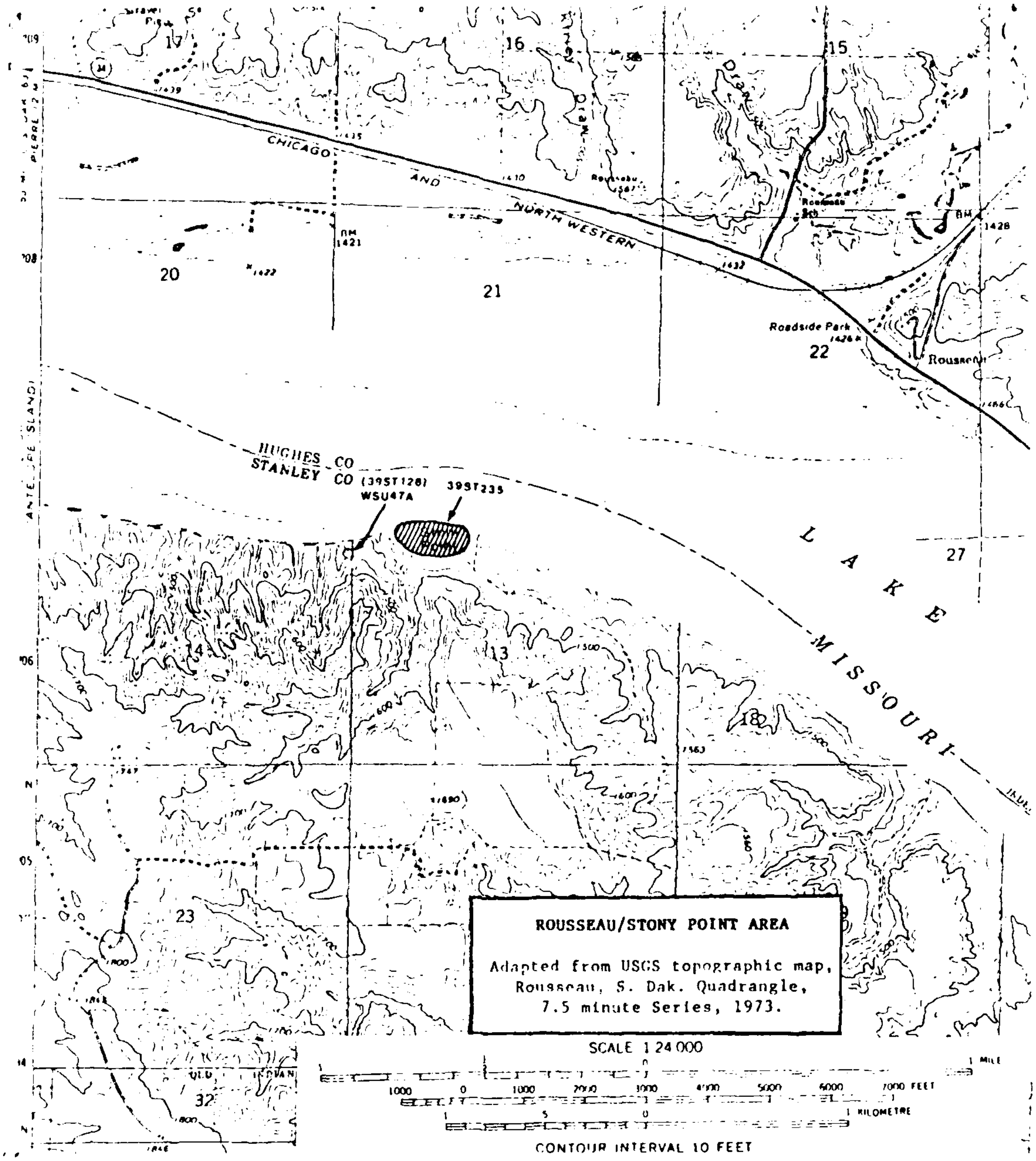


Figure 28. Location of sites 39ST126 and 39ST235 (Stony Point).

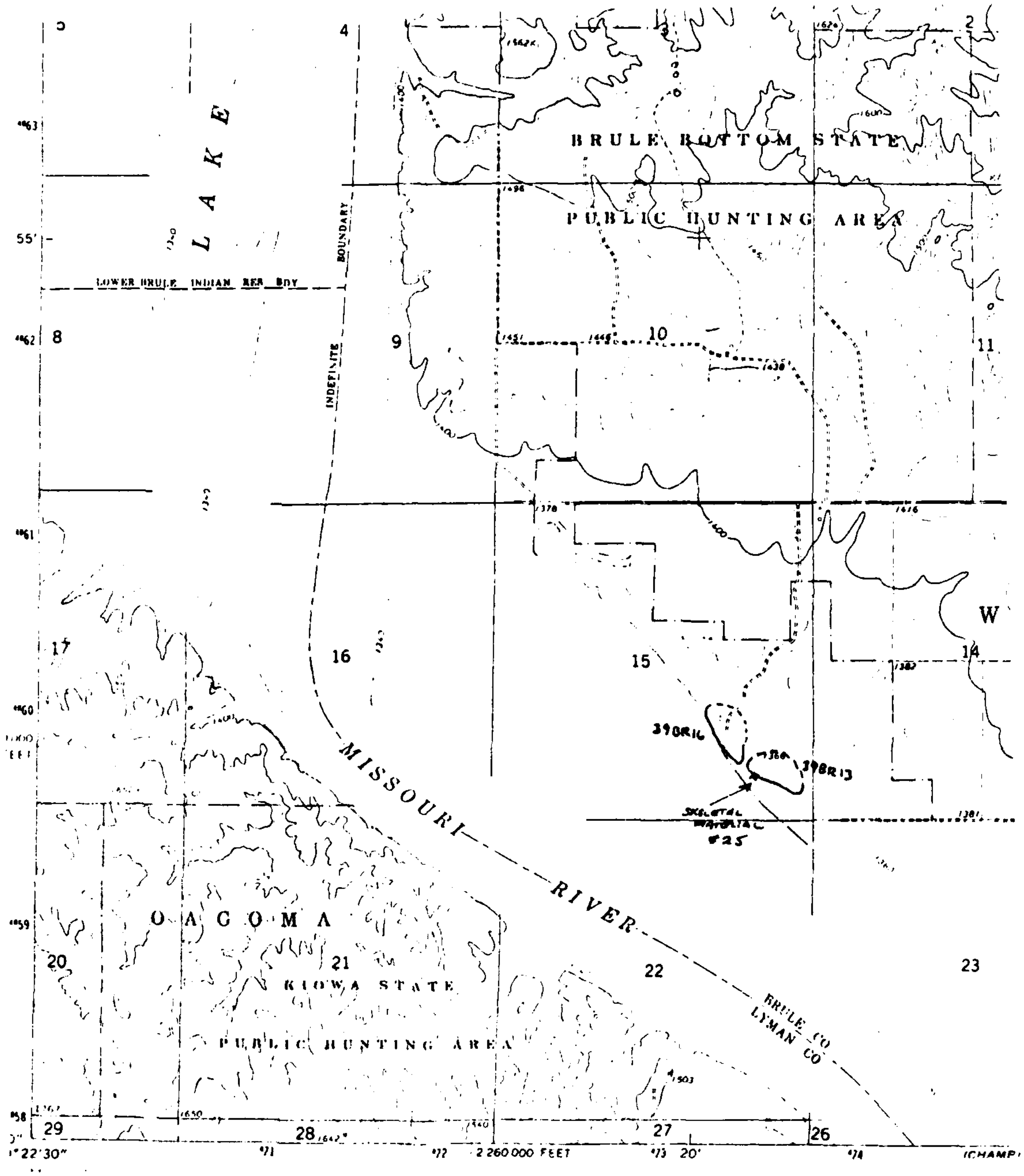


Figure 29. Map showing the locations of sites 39BR13 and 39BR16.

(x-8). Individual no. 2 is a young female (M_D=-1.1), with an age of 16-23 years based on the sequence of epiphyseal union. This individual is represented by a calvarium, a right innominate (x-7), a left femur (x-10), and left and right tibiae (x-9/x-11).

A scapula hoe fragment (see Section 8.10) apparently recovered with the burials provides no information concerning culture-historic position. Given the multi-component nature of 39BR13 these remains could be of any age. In the absence of intact crania, the human skeletal remains also provide no evidence as to their culture-historic position.

4.26 Exhibit X, Catalogue No. 26

Two skulls of unknown provenience were turned into the Archaeology Laboratory at the South Dakota State University, Brookings, South Dakota. They are presumed to have been collected somewhere along the Missouri River.

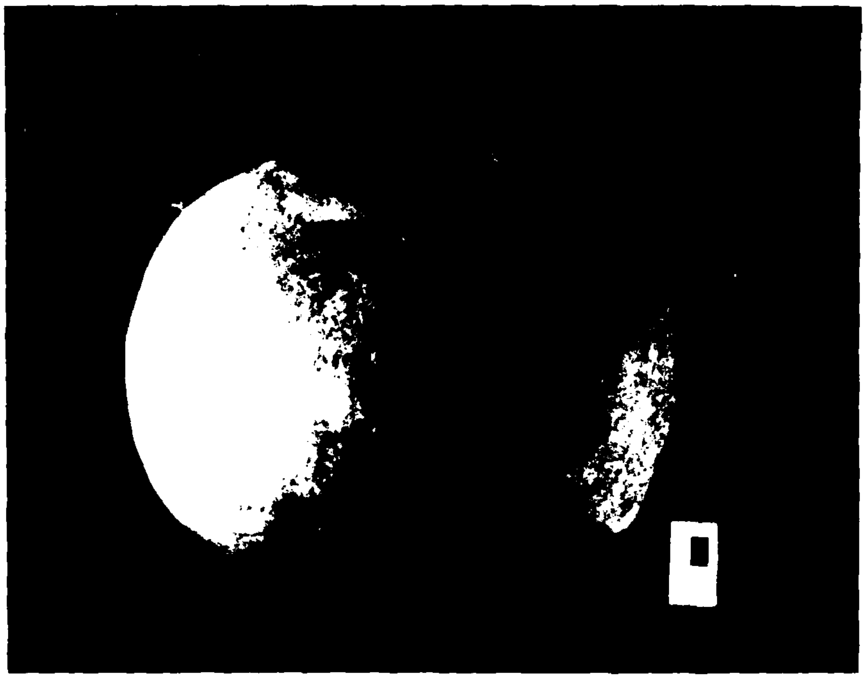
Both crania are of adult males. Both are heavily damaged lacking most of the facial skeleton. Individual no. 1 is represented by a well rounded (CI=79.7), but relatively low vaulted (AMHI=70.9), hypermuscular skull (M_S=0.4) (x-15) (Figure 30). Dental attrition indicates an age of 35-40 years. Individual no. 2 (M_S=1.0) is more heavily damaged. It is less broad (CI=77.1) and very low vaulted (AMHI=67.5) (Figure 31). The cranial sutures of this skull are fully closed endocranially and partially closed exocranially. This suggests an age in excess of 40 years (Krogman and Iscan 1986). The morphology of both crania is consistent with a Middle Missouri association. Beyond this, no further description or discussion is possible.

4.27 Sunrise Hill Site (39CH210) - Exhibit Y, Catalogue No. 27

On July 23, 1985 Mr. Timothy Nowak, Corps of Engineers field archaeologist, was notified by the Charles Mix County Sheriff's Office of exposed human skeletal remains along the beach at the North Point Recreation Area. Nowak inspected the site and recovered the exposed remains, together with one faunal element (see Section 9.11), which lie within the Sunrise Hill site (39CH210) (Figure 32). Examination of the in-situ remains indicated a primary flexed interment. High water prohibited complete recovery of the skeletal remains (Nowak 1985b).

The Sunrise Hill site is a partially inundated site located on the east bank of Lake Francis Case approximately 1 mile above the Fort Randall Dam in Charles Mix County (see Section 4.19) (Zimmerman and Emerson 1979). Two components have been identified at the site, Plains Woodland and possible Paleoindian (Tibesar et al. 1986:279). Previous excavations in 1964, 1978, and in 1983 failed to identify any burials.

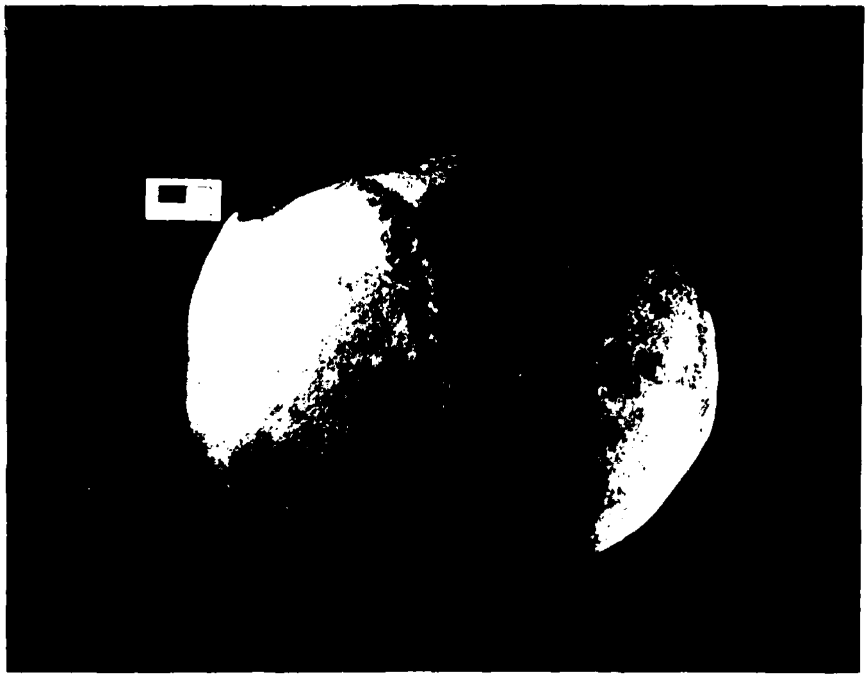
The fragmentary skeleton of a single adult female (M_S=-1.0), with a molar attrition age of 30-40 years, was recovered. The skeleton is very poorly preserved. Approximately 75% of the skeleton was recovered, including; the skull, major long bones, and portions of the thorax. The small bones of the



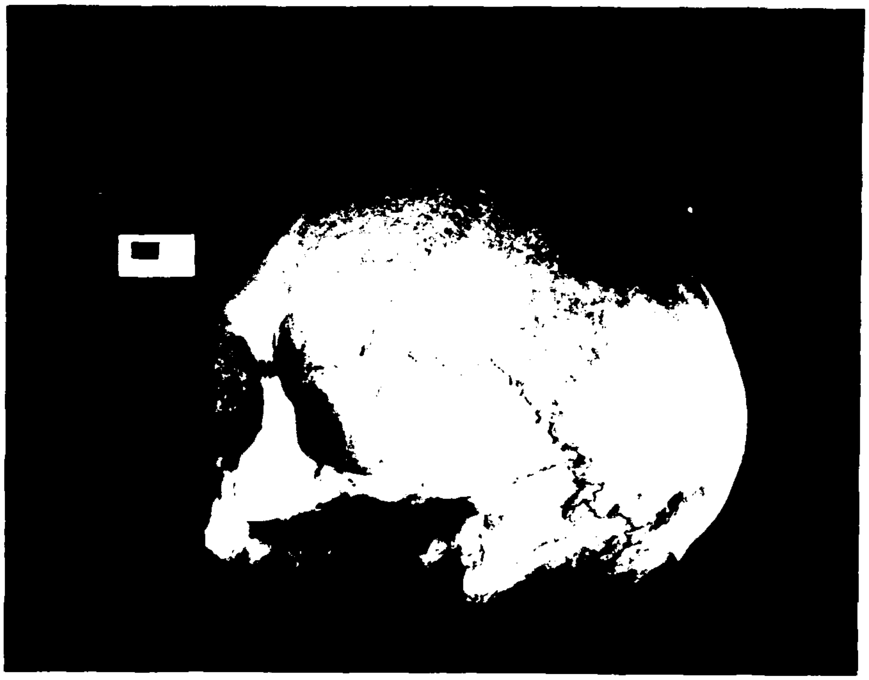
a.

b.

Figure 30. Cranium (x-13) presumably recovered from a location somewhere along the Missouri River (Exhibit X, Catalogue No. 26). a: superior, b: right lateral.



a.



b.

Figure 31. Cranium (x-14) presumably recovered from a location somewhere along the Missouri River (Exhibit X, Catalogue No. 26). a: superior, b: left lateral.

hands and feet, the vertebral column, and the innominates were not recovered and were apparently left in-situ. The skeletal remains are heavily covered with red ochre, suggesting a Woodland age. In the absence of artifacts and/or intact crania it is impossible to determine the culture-historic position of this burial and whether it is in fact associated with Sunrise Hill (39CH210).

4.28 Walth Bay Site (39WW203) - Exhibit Z, Catalogue No. 28

Recreators discovered a damaged human skull from the north side of Walth Bay on the east bank of Lake Oahe presumably from the Walth Bay site (39WW203). The remains were turned over to the park rangers at Mobridge, South Dakota.

The Walth Bay site, located approximately 12 miles downstream of Mobridge, is a multicomponent site that spans at least 7000 years and includes Late Paleoindian, Plains Archaic, as well as Plains Village occupations (Ahler et al. 1974). The Walth Bay site is one of numerous archaeological sites in the Mobridge area of Lake Oahe (see Sections 4.2, 4.3, 4.5, 4.8, 4.10, 4.11, and 4.16). Excavations were conducted at the site by the University of Missouri from 1970-1972, at which time several burials were recovered (Stan Ahler, personal communication). These burials have since been associated with the Extended Coalescent (Key 1983). No burials were recovered during a later survey conducted by the University of North Dakota in 1978 (Weston et al. 1979). Two burials of unknown provenience were also recovered by the South Dakota Archaeological Research Center (Willey et al. 1987).

A single adult male (M_S=1.9) cranium, with a molar attrition age of 35-40 years, was recovered. The skull is rounded and displays a lambdoidal flattening, suggestive of artificial cranial deformation. A yellow/green stain is also evident on the external surfaces. Although the skull is too poorly preserved to identify using a discriminant function, the pathologies present (see Section 6.23) are more typical of a post-Woodland pattern. This together with the gross morphology of the skull would suggest a Village association.

4.29 Platte Creek Recreation Area - Exhibit AA, Catalogue No. 29

On May 20, 1985 a resident of Platte, South Dakota turned in to Park rangers a single human cranium discovered along the Platte Creek on the east bank of Lake Francis Case in Charles Mix County.

Although no site is identified the legal location of these remains (NW¼ SW¼ NE¼ NE¼, Sec. 21, T98N, R69W) places it within the same quarter section as site 39CH38. This site was recorded by the Smithsonian Institution River Basin Surveys in 1947. No cultural diagnostic artifacts have been identified, and the site is today inundated by the waters of Lake Francis Case (Zimmerman and Emerson 1979:104).

The cranium recovered is of an adult female (M_S=-1.4), with a molar attrition age of 20-25 years. The skull displays evidence of

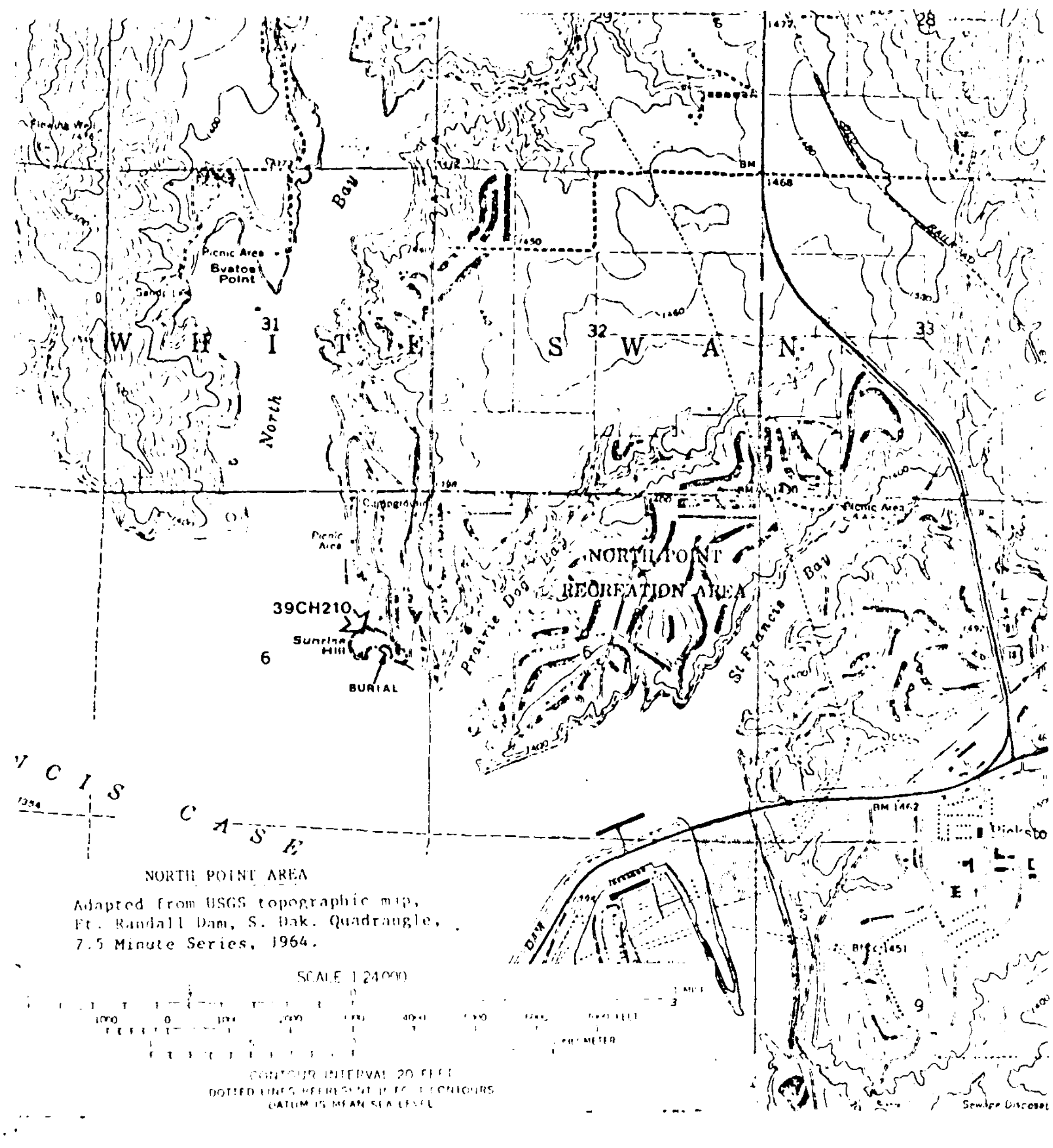


Figure 32. Location of burial recovered at Sunrise Hill (39CH210).

atmospheric/water degradation. The skull is rounded, of average shape (CI=76.4), but low vaulted (AMHI=69.8) (Figure 33). Although it is only slightly damaged a discriminant function was not possible. The overall morphology, especially the low vault height, is suggestive of a Woodland/Middle Missouri culture-historic position (Jantz and Willey 1983).

4.30 Brule Flat Village (39BR10) - Exhibit BB, Catalogue No. 30

Park rangers collected fragmentary human skeletal remains from the Brule Flat Village site (39BR10) along the east bank of Lake Francis Case in the Brule Bottom area of the Missouri River (see Section 4.25).

The Brule Flat Village is a combination of two previously recorded sites, 39BR2 and 39BR3 (Sigstad and Sigstad 1973; Zimmerman and Emerson 1979). The site is a fortified earthlodge village with an Extended Coalescent and possible Initial Middle Missouri component (Tibesar et al. 1986:192). No burials have previously been recorded at this site.

A partial calvarium of an adult of undetermined age (+23 years) was recovered. The muscularity of the calvarium suggests that it is of a male. No further identification of these remains is possible.

a.

b.

Figure 33. Cranium recovered from the Platte Creek Recreation Area (Exhibit AA, Catalogue No. 29). a: frontal, b: right lateral.

5.0 DENTITION

5.1 Introduction

Although a large number of crania were recovered from these sites, the number of intact dentitions was disappointingly few. The greatest contributor to this data base reduction was postmortem tooth loss (Table 10). This took one of two forms. For thirteen adult crania, the mandible and/or the maxilla was missing entirely so that no permanent teeth were recovered for those dentaries. For the remainder, one or more individual teeth were missing. The morphology of the tooth alveolus was used to differentiate postmortem loss from antemortem exfoliation . Tooth loss was attributed to postmortem events when the socket was intact with no evidence of apical abscessing, and/or when the alveolar bone displayed minimal resorption or other bony changes which accompany periodontal disease. All other cases of tooth loss were classified

Table 10. Postmortem tooth loss of the permanent dentition.

Dentary	Potential #[1]	Actual #	% Lost
a-4/5	32	32	0
c-1	32	14[2]	56
c-2	29	21[3]	28
d-1	30	12[2]	60
e-1	28	26	7
f-1/2	20	14[4]	30
h-2/1	30	30	0
i-1	30	18	40
j-1/2	20	13[4]	35
k-1	32	10	62
o-6	28	28	0
p-50/52	16	16[4]	0
t-6	32	30	6
u-2	32	1	97
v-45/43	27	19	30
v-42	32	10[2]	69
v-68	32	0[5]	100
w-42	32	11[6]	66

Table 10. Continued.

Cranium	Potential #[1]	Actual #	% Lost
x-3	32	0[5]	100
x-14	32	0[5]	100
x-15	32	3[5]	91
y-3	32	5[6]	84
z-1	32	0[5]	100
aa-1	32	13[2]	59
bb-1	32	0[5]	100

[1]takes into account antemortem loss, excluding four edentulous crania

[2]mandible missing

[3]partial mandible

[4]mixed dentition

[5]mandible and maxilla missing

[6]maxilla missing

as antemortem. Of 738 potentially retrievable permanent teeth only 326 were recovered (44.2%). This percentage is not entirely accurate in that the total of potentially recoverable teeth does not take into account any antemortem loss that may have occurred on the missing dentaries. Four functionally edentulous crania were also not tallied in the total. Although a large number of teeth were recovered, the vast majority of these were moderately to excessively worn (see Section 5.2) and/or damaged. No attempt was made to document the percentage of deciduous teeth present. However, these were clearly underrepresented given the number of juvenile crania. As a result metric and non-metric descriptors are very limited (see Appendix F).

5.2 Enamel Attrition and Related Features

While enamel attrition leads to the loss of descriptive data, it is itself a source of information. Various studies have substantiated the observation that diet plays a role in the rate and severity of enamel wear (e.g., Hinton 1982; Molnar 1971; Patterson 1984; Smith 1984). Generally speaking, pre-horticultural diets are more abrasive, coarser, and less processed than their horticultural counterparts. Hunter/gatherers therefore display a higher

level of attrition at earlier ages. It is unusual, for example, to find significant crown surfaces remaining in northern Plains Woodland skeletons of individuals older than 45 years of age. Even by the age of 35 the molars and incisors exhibit advanced dentin exposure with secondary dentin formation (Williams 1982a, 1985a, 1985c)

Two forms of enamel wear were assessed for the permanent dentitions, occlusal and interproximal. Occlusal wear of the first permanent molar was recorded using the scale created by Smith (1984:46) in which attrition is divided into eight stages or grades. As can be expected when sampling individuals of various ages and culture-historic associations, occlusal attrition ranged from unworn (grade 1) in young juveniles to the complete loss of the crown (grade 8) in adults over the age 40 years (Table 11). Individuals with pre to early Village association, such as those from Blue Blanket Point (39WW98) (see Sections 4.10, 4.11 and 4.16), appear to display advanced levels of attrition at a relatively early age. At the other end of the spectrum, the older adult female from the Extended/Post-Contact Coalescent Scalp Creek Cemetery (39ST126) (see Section 4.24) has moderately worn teeth at a relatively old age.

In cases of advanced attrition where antemortem tooth loss is minimal a form of wear described as helicoidal has been observed in both prehistoric and extant populations (Butler 1972; Dahlberg 1963; Smith 1984). This is a compound pattern of occlusal wear involving variable pitch in the angle of wear (Butler 1972; Murphy 1959a, 1959b). As age and attrition progress, the maxillary teeth wear more heavily on the lingual surface while the mandibular teeth wear more heavily in a complimentary fashion on the buccal surface. In a study conducted by Smith (1984), horticulturalists displayed higher wear angles than did hunter/gatherers, whose wear patterns tended to be more uniform. This difference in wear pattern appears to be related to the coarser, tougher, more fibrous pre-horticultural diet. Two individuals displayed this helicoidal wear pattern (individual no. 4, Blue Blanket Point (39WW98) and individual no. 1, (39LM256)) (see Sections 4.10 and 4.23).

Interproximal or interstitial wear is enamel attrition that occurs at the mesial and distal contact points between adjacent teeth. It is seen as the result of two factors, mesial or forward packing of the teeth, and mesially applied masticatory force (Hinton 1982; Wolpoff 1971). While this wear can occur in any population, it is most pronounced among those peoples who exert excessive masticatory force due to diet and/or food preparation. Elevated levels of interproximal wear have been documented for extant and prehistoric hunter/gatherers (Hinton 1982; Murphy 1964; Williams 1985a, 1985c; Wolpoff 1971). In these populations it can reduce the mesial-distal length of the dental arcade by more than 20 mm. Modern industrialized populations typically display less than 1 mm of lifetime reduction in mesial-distal length (Kraus et al. 1980). While interproximal wear can occur between any two teeth it is between the molars that the greatest degree of wear takes place. Here the mesial masticatory forces bear directly on the broad molar contact surfaces.

Assessing interproximal wear is hampered by occlusal attrition. Interproximal, like occlusal wear, is age-progressive. Higher levels are expected in older individuals. However, as the occlusal surface wears down so

Table 11. Occlusal attrition at the first molar.

Individual	Age	Sex	Wear Grade
39CO34			
no. 1	32-52	female	6
39SL4			
no. 1	30-35	male	7
no. 2	30-35	female	7
Bl. Blanket Rec. Area - Ex.D			
no. 1	40-45	male	8
Bl. Blanket Rec. Area - Ex.E			
no. 1	23-39	male	6/7
Fort Thompson Area			
no. 1	8.0-8.5	na	1
39HU203			
no. 1	30-39	male	6
39WW98 - Exhibit I			
no. 4	40-47	female	8
no. 5	+50	male	na[1]
39WW98 - Exhibit J			
no. 1	ca12	na	4
Pike Haven Rec. Area			
no 1.	ca17	female	5
Brush Creek Area			
no. 1	ca50	female	na[1]
39WW98 - Exhibit O			
no. 1	11-12	na	4
Okobojo Point			
no. 1	6-7	na	2
39LM57			
no. 1	+45	female	na[1]
no. 3	20-25	na	3/5

Table 11. Continued.

Individual	Age	Sex	Wear Grade
39GR32			
no. 1	ca15	na	3
39LM256			
no. 1	40-45	male	8
no. 5	40-45	female	na[1]
no. 6	30-35	female	7
39ST126			
no. 1	44-54	female	4
Exhibit X			
no. 2	+23	male	6
39CH210			
no. 1	30-40	female	7
Platte Creek Rec. Area			
no. 1	20-25	female	3

[1]edentulous

too does the interproximal wear facet. As extreme levels of crown reduction are reached interproximal wear can no longer be measured. Measurable interproximal wear is therefore a characteristic of subadults and young adults. The primary difference between horticultural and pre-horticultural populations is in the age at which equivalent levels of wear take place. With so few intact and relatively unworn permanent dentitions, the number of measurable interproximal wear facets was limited (Table 12). These wear facet dimensions are comparable with those recorded for other northern Plains populations (Williams 1982a, 1985a, 1985c). With such small sample sizes, however, it is impossible to control for age, attritional status, and culture-historic association. Thus it is unclear what this similarity in wear levels means.

Other than these simple observations, the small sample sizes involved make it difficult to draw any concrete conclusions regarding occlusal attrition.

Although not strictly speaking a form of attrition, tooth trauma is an analogous phenomenon. The most common forms of trauma are chipping and fracturing. The major difference between these two forms of trauma is one of

Table 12. Interproximal wear in mm[1].

Wear Facet	a-1		c-1		c-2		d-1		e-1	
	l	r	l	r	l	r	l	r	l	r
$P_4 - M_1$	5.95	5.21	--	--	3.75	4.75	--	--	3.90	4.40
$M_1 - M_2$	5.93	5.73	--	--	5.85	5.27	--	--	4.45	--
$M_2 - M_3$	3.20	4.47	--	--	--	--	--	--	5.05	5.20
$P^4 - M^1$	8.38	6.53	8.25	5.62	--	3.90	--	--	--	--
$M^1 - M^2$	5.35	6.59	7.75	5.60	6.09	--	--	--	--	--
$M^2 - M^3$	4.52	4.74	5.63	4.13	--	--	4.90	4.40	--	--

Table 12. Continued.

Wear Facet	h-2		o-6		t-		v-		y-3	
	l	r	l	r	l	r	l	r	l	r
$P_4 - M_1$	4.40	3.07	--	--	--	--	--	--	--	--
$M_1 - M_2$	5.75	4.74	4.10	--	3.90	--	--	--	--	--
$M_2 - M_3$	5.13	3.96	--	--	--	--	--	--	5.40	--
$P^4 - M^1$	5.24	4.87	--	--	--	--	--	--	--	--
$M^1 - M^2$	5.59	4.19	4.00	3.60	--	4.00	--	5.40	6.40	--
$M^2 - M^3$	--	--	--	--	--	4.30	--	4.20	4.30	5.30

[1]subscripts and superscripts denote respectively, mandibular and maxillary dentition

degree. Chipping is the removal of small flakes of enamel, while fracturing involves a more substantial portion of the occlusal surface and the underlying dentin (Turner and Cadien 1969). Such damage may or may not result in exfoliation of the traumatized tooth. The level of tooth trauma in a population is in direct proportion to the level of food processing and abrasive particles in the diet (Wallace 1974). Pre-horticultural Archaic and Woodland populations therefore display higher levels of tooth trauma than do horticultural societies (Patterson 1984; Williams 1985c). Three individuals displayed evidence of tooth trauma. The adult male recovered from the Blue

Blanket Recreation Area (see Section 4.6) had a massive fracture of the maxillary right fourth premolar. The root was fully exposed and polished, indicating a substantial period of time had elapsed since the fracture episode. The adult male recovered from the Howes site (39HU203) (see Section 4.9) displayed chipping of the occlusal surface of the maxillary left first molar. Last, an adult female, individual no. 6 from site 39LM256 (see Section 4.23), exhibited a single enamel fracture on the buccal surface of the maxillary right first molar.

5.3 Periodontal Disease, Abscessing, and Related Conditions

Periodontal disease is an inflammation of the gingival tissue and the alveolar bone (cf., Bhaskar 1981; Carranza 1984; Grant et al. 1979; Shafer et al. 1983). This inflammation comes primarily from bacterial utilization of nutrients trapped in the periodontium. Initially this results in gingivitis, a chronic low grade inflammation of the gingiva due to the accumulation of plaque. If this process progresses and subgingival calculus builds up, infradental pockets and craters form in the alveolar bone between and around each tooth. This more serious inflammation is periodontitis. In addition to the characteristic infradental pockets and craters, alveolar resorption also occurs. As the alveolar bone apically recedes the tooth roots are exposed, weakening alveolar attachment. Periodontal disease is the most common cause of tooth loss in later life. Abscessing is another consequence of advanced periodontitis. Although a deficiency of calcium and/or an excess of phosphorous in the diet may play a role in periodontal disease no clear associations have been made (Costa 1982; Grant et al. 1979; Patterson 1984). It is suggested that highly processed diets, leading to a lessened ability to control oral hygiene, are more likely to cause periodontitis.

Periodontal disease can be assessed in a variety of manners taking into account morphological changes in the alveolar bone (i.e., the formation of infrabony pockets and craters) and alveolar resorption (Costa 1982; Patterson 1984). This analysis recorded only the degree of alveolar resorption (Table 13). Resorption ranged from less than one millimeter in four juveniles to more than seven millimeters in an adult male (individual no. 1) from the Sully site (see Section 4.4). In overall range these levels of periodontal resorption are comparable with those obtained from other northern Plains samples (Williams 1985a, 1985c). Patterson (1984:91) regards any resorption of less than 2 mm as indicative of no periodontal disease involvement. Using this criterion six of the thirteen individuals with measurable resorption would be classified as having little or no periodontal disease. In this regard, the 44-54 year old female from site 39ST126 is noteworthy in having minimal resorption at an advanced age. At the other extreme, four similarly aged adults were nearly completely edentulous with fully remodeled alveolar margins. This is characteristic of advanced periodontal disease with resulting tooth exfoliation. As is expected, those individuals with low to moderate resorption also had little or no evidence of tooth exfoliation. Even advanced resorption did not necessarily result in tooth loss. Two individuals while not edentulous had such extreme occlusal attrition that the crown surface had been fully abraded. This together with nearly complete root exposure made it impossible to evaluate the level of resorption for these

Table 13. Alveolar resorption at M1 and the number of exfoliated teeth[1].

Individual	Resorption in mm	# Exfoliated
Red Horse Hawk (39CO34)		
Individual no.1	2.2	0
Sully (39SL4)		
Individual no. 1	7.3	0
Individual no. 2	4.3	2
Blue Blanket Recreation Area - Exhibit D		
Individual no. 1	5.8	0
Blue Blanket Recreation Area - Exhibit E		
Individual no. 1	2.9[2]	0
Fort Thompson Area - Exhibit F		
Individual no. 1	<1.0	0
Howes (39HU203)		
Individual no. 1	2.9	0
Blue Blanket Point (39WW98) - Exhibit I		
Individual no. 4	na[3]	0
Individual no. 5	na[4]	29
Blue Blanket Point (39WW98) - Exhibit J		
Individual no. 1	<1.0	0
Pike Haven Recreation Area - Exhibit K		
Individual no. 1	<1.0	0
Brush Creek Area - Exhibit M		
Individual no. 1	na[5]	32
Blue Blanket Point (39WW98) - Exhibit O		
Individual no. 1	<1.0	0
Fort Lookout II (39LM57) - Exhibit T		
Individual no. 1	na[4]	10
39LM256		
Individual no. 1	na[7]	4
Individual no. 5	na4	23
Individual no. 6	5.1	0

Table 13. Continued.

Individual	Resorption in mm	# Exfoliated
39ST126		
Individual no.1	1.9	0
Sunrise Hill (39CH210)		
Individual No. 1	4.2	0
Platte Creek Recreation Area - Exhibit AA		
Individual no. 1	1.3	0

[1]no apical abscess involvement

[2]measured at M2

[3]advanced occlusal attrition

[4]functionally edentulous

[5]edentulous

[6]advanced occlusal attrition

individuals other than to characterize it as extreme.

Periodontal disease was clearly present but variable in its expression, a reflection of not only different aged individuals, but different culture-historic associations, and different dietary patterns.

Dental calculus is implicated in the incidence of periodontitis. Calculus is the calcified accumulation of plaque deposits. Supragingival calculus deposits ranging from mild to excessive were observed on the dentitions of eight individuals (Table 14). That more individuals were not observed with calculus deposits is probably a reflection of postmortem tooth loss. Previous studies of northern Plains populations have shown excessive deposits even among Woodland samples where a coarse diet is less conducive to the initial plaque formation (Grant et al. 1979; Williams 1985a, 1985c). Not unexpectedly, those individuals with mild deposits also displayed little or no periodontal resorption while the opposite was true for those individuals with excessive deposits.

Apical abscessing, another common dental pathology, was observed in ten individuals (Table 15). The number of abscesses ranged from a single occurrence (two individuals) to four or more (four individuals). Of the 29

Table 14. Calculus deposits.

Individual	Location	Level	Periodontitis[1]
Red Horse Hawk (39CO34)			
Individual no. 1	molars	mild	none
Sully (39SL4)			
Individual no. 2	molars	excessive	moderate
Bl. Blanket Rec.Area - Ex.E			
Individual no. 1	molars	mild	mild
Bl. Blanket Pt. (39WW98) - Ex.J			
Individual no. 1	incisors	moderate	none
Bl. Blanket Pt. (39WW98) - Ex.O			
Individual no. 1	incisors	mild	none
39LM256			
Individual no. 1	molars	moderate	na
Individual no. 5	molars	moderate	na
Individual no. 6	molars	moderate	severe

[1]as indicated by periodontal resorption

alveolar abscesses, the teeth of 16 (55%) were exfoliated as a result (Figure 34). One abscess included sinus involvement (see Section 6.10). Although these individuals are not representative of a single population, the abscess incidence is comparable with that obtained for other northern Plains populations (Williams 1985a, 1985c).

Periapical abscesses represent bacterial infection of the tooth pulp and necrosis of the surrounding periapical tissue. For an infection to occur, physical exposure of the pulp usually must take place. Extensive carious lesions and excessive occlusal attrition are common causes of pulp exposure. One or both of these conditions (see Sections 5.2 and 5.4) is present among these individuals.

5.4 Caries

A high caries incidence has long been recognized as a characteristic feature of a processed food diet. Carious lesions are infrequent among pre-horticultural societies where coarse, low carbohydrate foodstuffs are

Figure 34. Periapical abscesses and severe periodontal resorption, individual no. 4, Blue Blanket Point (39WW98) (Exhibit I, Catalogue No. 9/10). Note extreme occlusal attrition and helicoidal wear pattern.

Table 15. Apical abscessing.

Individual	Tooth	Exfoliation
Sully (39SL4)		
Individual no. 1	rM^1	yes
	rP^4	no
Bl. Blanket Rec. Area - Ex.D		
Individual no. 1	rM^1	yes
	rM^2	yes
	lM^1	no
Bl. Blanket Rec. Area - Ex.E		
Individual no. 1	rM^1	yes
	rM^2	yes
	rM^3	yes
Howes (39HU203)		
Individual no. 1	rM_1	yes
Bl. Blanket Pt. (39WW98) - Ex.I		
Individual no. 4	rM^2	yes
	rM^3	yes
	lM_2	no
	rM_2	no
Individual no. 5	lI_2	no
	rI_2	no
	lP_4	no
	rP_4	no
39LM57		
Individual no. 1	$lC\_$	yes
	rP^4	no
39LM256		
Individual no. 1	lM^2	no
	rM^2	no

Table 15. Continued.

Individual	Tooth	Exfoliation
39LM256		
Individual no. 1	lM_1	no
	lM_2	yes
	lM_3	yes
Individual no. 5	lI_2	yes
	lC_-	yes
	rM_3	yes
	lM^2	yes
Walth Bay (39WW203)		
Individual no. 1	rM^1	no

relatively non-cariogenic (e.g., Patterson 1984:70-72). Dental caries is a complex infectious disease of the external surface of the tooth. A variety of bacteria, primarily Streptococcus sp., each existing at different points on the tooth surface, produce decalcifying acids (Bhaskar 1981; Legler and Menaker 1980; Morhart and Fitzgerald 1980). If unchecked, dissolution of the enamel and organic matrix continues, involving the underlying dentin and eventually the pulp. Recent studies have indicated that physiological and possibly external environmental factors may also be implicated in caries incidence (Curzon 1983; Curzon and Cutress 1983; Hildebolt et al. 1988). Schneider (1986) in a study of lower Great Lakes populations reports that zinc, copper, and iron when present in enamel have a cariostatic effect while nickel has a cariogenic effect. Results such as these suggest that diet may play a multifaceted role in the production of carious lesions.

Carious lesions are generally categorized on the basis of location. These are pit/fissure, located in the grooves and pits of the occlusal surface, smooth surface, located on the sides of the crown, and radicular or root caries, located on the root surface usually near the cementum-enamel junction (Legler and Menaker 1980; Ostrom 1980). A total of 20 carious lesions were found on eighteen permanent teeth of eight individuals (Table 16). Eight lesions were pit/fissure (Figures 35-37), eleven were radicular, and one was a smooth surface caries. This pattern is indicative of dietary circumstances leading to the accumulation of refined carbohydrates in the pits and fissures of the occlusal surface and in the interproximal areas. In contrast, Woodland populations in the northern Plains have a very low incidence of both types of caries (Williams 1985a, 1985c, 1987).

Table 16. Caries distribution.

Individual	Pit/Fissure	Radicular	Smooth Surface
Red Horse Hawk (39CO34)			
Individual no. 1	lM_2^a	lM^1, lM^2	
Sully (39SL4)			
Individual no. 2	lM^1, lM^2, lM^3		
Blue Blanket Recreation Area - Exhibit D			
Individual no. 1	lM^3, rM^3		
Blue Blanket Recreation Area - Exhibit E			
Individual no. 1	lM^1	lM^{2b}, lM^3	
Howes (39HU203)			
Individual no. 1	rM_3, rM^2		
Fort Lookout II (39LM57)			
Individual no. 1	rP_4		
Individual no. 3		rM^{2b}	lM_2
Platte Creek Recreation Area - Exhibit AA			
Individual no. 1	rM^2, lM^3		

[a]buccal pit

[b]mesial and distal surfaces

5.5 Enamel Hypoplasia

Enamel hypoplasia or chronologic enamel aplasia is generally defined as any macroscopic or visible defect in the enamel surface (Pindborg 1970; Sarnat and Schour 1941, 1942). Hypoplastic defects can range from minor depressions in the enamel surface with no dentin exposure, to a complete disruption of the enamel. These defects appear either as band-like depressions (linear enamel hypoplasia) or as pits on contralateral teeth. The microscopic histology of the enamel is also altered and can serve as an additional diagnostic feature (Rose 1977; Rose et al. 1978). Numerous causal agents have been implicated inthe presence of hypoplasias. Specific and non-specific infections are commonly implicated where antibiotic treatment is unavailable (Sweeney et al. 1969). High fever, whether of infectious origin or not, has clearly been linked in laboratory studies (Kreshover 1960; Kreshover and Clough 1953). Vitamin deficiencies and malnutrition have also been cited as sources (Cook

Figure 35. Pit/fissure caries, rM^2 (Platte Creek Recreation Area) (Exhibit AA, Catalogue No. 29).

Figure 36. Pit/Fissure caries, $1M^3$ (Blue Blanket Recreation Area)(Exhibit D, Catalogue No. 4).

Figure 37. Pit/fissure caries, lM^2, lM^3, individual no. 2, Sully (39SL4) (Exhibit C, Catalogue No. 3).

and Buikstra 1979; Giro 1947; Sarnat and Schour 1941, 1942). In general, any major systemic alteration enhances the probability of a hypoplastic episode.

The characteristic appearance of hypoplastic defects has its basis in tooth growth and enamel deposition. Teeth grow from three different groups of blast cells, each developing a different component of the tooth, enamel, dentin, and cementum. As the tooth bud or anlage appears these cells initiate the production of their specific products. The odontoblasts begin first by depositing dentin creating the framework for the enamel. Ameloblasts follow this pattern depositing enamel over the dentin. Both enamel and dentin are laid down in a manner analogous to tree growth rings. The last set of cells, the osteoblasts, lie outside of the tooth anlage and deposit cementum on the completed dentin and enamel.

Because dentin and enamel are deposited in concentric layers any disruption of the blast cells results in a hypoplasia on that particular ring. Under strong enough stress the ameloblasts are unable to repair the hypoplasia resulting in various forms of insufficient or non-existent enamelogenesis and clinical hypoplasia (El Najjar et al. 1978; Giro 1947; Kreshover 1944; Massler et al. 1941; Orban 1957; Pindborg 1970; Sarnat and Schour 1941, 1942). The appearance of a hypoplasia on a particular tooth is a function of when the enamel of that tooth is being deposited. This is a timed event specific to each tooth class and type. Beginning with the maxillary central incisors, the deciduous teeth begin to mineralize at approximately the fourth month of gestation. The last primary tooth to mineralize is the second molar, which does so by 8 months of age. The deciduous teeth are therefore good indicators of systemic stress only during the prenatal and early neonatal stages (Blakey and Armelagos 1985). The permanent dentition covers a longer period of time, not beginning mineralization until after birth, and continuing to form through 6-8 years. This makes the permanent dentition a good indicator of early childhood stress. The majority of enamel hypoplasias, however, occur during the first two years of life, tapering off by the fourth year. Usually only one class of tooth is affected, marking a short period of systemic stress. If the stress is severe enough and of a long enough duration the hypoplasia may be seen on several teeth.

Six individuals were found to display one or more hypoplastic episodes (Table 17). With one exception these hypoplasias involved only the canine. The canines mineralize during the first six to six and a half years of life, which for the growing child are the most stressful. This tooth is therefore a common site for hypoplastic defects and invariably displays them when such defects are present in the dentition (Goodman et al. 1980). Where contralateral teeth were present both displayed the same banding pattern. Only one of the hypoplastic defects was circular, the remainder were all linear enamel hypoplasia. The number of episodes per tooth ranged from one (two individuals) to four (one individual). Following the procedure outlined by Goodman et al. (1980) these hypoplasias marked stress episodes ranging from 1 year to 5.5 years of age. Eleven of the 17 episodes (65%) fell between 3.0 and 4.5 years, most likely marking a period of weaning stress (Goodman et al. 1984, 1987). None of the hypoplasias was severe enough to cause dentin exposure, however.

Table 17. Hypoplastic episodes.

Individual	Tooth	Episode (mm)	Age(years)
Bl. Blanket Rec. Area - Exhibit D			
Individual no. 1	l/rC^{-}	1.5	5.0
	l/rC^{-}	2.7	4.5
Fort Thompson Area			
Individual no. 1	rC_{-}	1.5	5.0
	rC_{-}	3.2	4.1
	rC_{-}	4.1	3.5
Blue Blanket Point - Exhibit J			
Individual no. 1	rC^{-}	2.0	4.3
	rC^{-}	3.5	3.9
	rC^{-}	5.7	3.0
	rC^{-}	8.5	1.0
Pike Haven Recreation Area			
Individual no. 1	rC^{-}	3.1	5.5
Blue Blanket Point - Exhibit O			
Individual no. 1	lC_{-}	7.8	1.5
Okobojo Point			
Individual no. 1	rC_{-}	5.2	3.0
	rC^{-}	4.0	3.5
	l/rI^{1}	2.7	3.5

Where multiple hypoplastic episodes existed (Figure 38), the spacing between them ranged from 0.5 to 2.0 years. Goodman et al. (1980) theorize that the yearly spacing of hypoplastic episodes corresponds with a seasonal stress, possibly related to maize horticulture. Spacing of less than one year is more commonly found among Woodland populations. Regionally comparable samples are restricted to Woodland populations of the Northeastern Plains which have an extremely low rate of hypoplastic defects (Williams 1982a, 1985a, 1985c, n.d.). Elsewhere, Patterson (1984) reports that hypoplasias are equally common among pre-horticultural and horticultural populations of the Great Lakes region. In the Illinois valley the number of hypoplastic episodes increased with the transition from the Middle to Late Woodland and to the Mississippian (Cook and Buikstra 1979; Goodman et al. 1980, 1984).

Figure 38. Multiple linear enamel hypoplastic episodes, rC^{-} (Blue Blanket Recreation Area) (Exhibit D, Catalogue No. 4). Note apical abscess and exfoliation of rM^1 and rM^2.

Unfortunately, given the high percentage of postmortem tooth loss, coupled with high levels of attrition, it is impossible to determine what the true extent of hypoplasias is among the individuals represented by these remains. Stresses at the youngest ages (i.e., 1.0 year), for example, are only recorded in the juveniles as these hypoplastic episodes occur high up on the tooth crown and are usually lost to attrition by young adulthood.

5.5 Miscellaneous Anomalies and Pathologies

Four individuals (Table 18) displayed interproximal grooving. This unusual acquired defect is not fully understood. This grooving takes the form of a shallow polished trough on the mesial or distal interproximal surface of the tooth at the cementum-enamel junction, almost exclusively involving the molars (Figure 39). The most common reason given for these anomalies is the use of a dental probe to remove food particles from between teeth (Berryman et al. 1979; Frayer and Russell 1987; Ubelaker et al. 1969). Wallace (1974) disagrees with this conclusion and argues that grit in food or water is the causative agent. The common association of incipient carious lesions with these grooves suggests that the removal of trapped food particles is more probable.

Three other anomalous/pathologic states were identified (Table 19). These included a case of molar agenesis, and two minor malocclusions. All three had minimal impact on the overall dental health of the individuals involved. The two malocclusions both resulted in alterations of the normal attritional pattern. For the juvenile from Blue Blanket Point (39WW98), the mandibular first molars were both worn to a level well beyond that expected for the individual's age. The opposite was true for the adult female from site 39LM256. Here the mesial displacement of the mandibular canines removed them from occlusal contact with their maxillary counterparts. As a result they were virtually unworn.

Figure 3[illegible]. Interproximal grooving, LM^1 (Red Horse Hawk (39C034) (Exhibit A, Catalogue No. 1).

Table 18. Interproximal grooving.

Individual	Tooth	Surface
Red Horse Hawk (39CO34)		
Individual no. 1	lM^1	distal
Sully (39Sl4)		
Individual no. 1	lM^3	mesial
Howes (39HU203)		
Individual no. 1	lM^2	distal
39LM256		
Individual no. 1	rM^3	mesial

Table 19. Miscellaneous anomalies/pathologies of the permanent dentitions.

Individual	Condition
Howes (39HU203)	
Individual no. 1	agenesis, rM^3
Blue Blanket Point (39WW98)	
Individual no. 1	severe mesial tilt, l/r M_1 and impacted l/r M_2
39LM256	
Individual no. 6	mesial displacement, l/r C_-

6.0 ANOMALIES, PATHOLOGIES, AND ASSOCIATED PARAMETERS

6.1 Introduction

Although these individuals are not part of a unified skeletal sample the identification of anomalous and pathologic states can still provide a basic understanding of the health parameters of the populations from which they are derived. At least thirty of the fifty-five individuals displayed one or more anomalous or pathologic states. These ranged in severity from asymptomatic developmental anomalies such as sacralization and lumbarization to severe arthritis and non-specific infection. The majority of the identified pathologies were non-life threatening and were at worst debilitating. These anomalous and pathologic states are described below by site, together with the most probable diagnosis. Where multiple individuals within a site existed, pathologies are identified by individual or marked as unassigned.

6.2 Red Horse Hawk site (39CO34) - Exhibit A, Catalogue No. 1

Description

Mild erosion of the articular surfaces of the right humerus, left and right femora, left and right tibiae, left and right tali (including an erosive pit on the trochlea of the left humerus). Mild lipping of the articular surfaces of the left radius and the trochlea of the left ulna.

Diagnosis: *Mild to moderate degenerative joint disease [DJD]* (see Section 6.26).

Description

A moderate periosteal reaction on the popliteal area of the posterior left femur, superior to the medial condyle. This osteosclerotic lesion approximates a "thumbprint" in appearance and is 14 mm in diameter.

Diagnosis: Moderate inflammation of the medial head of the gastrocnemius muscle (see Section 6.27).

Description

A mild periosteal reaction on the tibial tuberosity of the right tibia.

Diagnosis: Mild inflammation of the patellar ligament.

Description

Partial lumbarization of the first sacral vertebra [S1].

Diagnosis: Anomalous developmental variation of undetermined origin (see Section 6.28).

Description

Spondylolysis of the fifth lumbar vertebra [L5] and partial spondylolysis of the third lumbar [L3] and twelfth thoracic vertebrae [T12].

Diagnosis: Anomalous developmental variation of undetermined origin.

Description
Ossified first costal cartilage.

Diagnosis: Normal osseous response to aging (see Section 6.29).

Description
Incipient fusion of the sacro-iliac articulation.

Diagnosis: Normal osseous response to aging.

Description
Moderate to severe osteophyte formation on L3 and L5 (Figure 40

Diagnosis: Moderate to severe vertebral osteophytosis (see Section 6.26).

6.3 Anton Rygh Site (39CA4) - Exhibit B, Catalogue No. 2A

Description
Mild to moderate erosion of the articular surfaces of the right clavicle, and proximal left tibia. Mild lipping of the articular surfaces of the distal right ulna and right radius.

Diagnosis: Mild to moderate degenerative joint disease.

Description
Mild to moderate osteophyte formation on L3, L4 and L5.

Diagnosis: Mild to moderate vertebral osteophytosis.

Description
Incipient fusion of the sacro-iliac articulation.

Diagnosis: Normal osseous response to aging.

Description
Pronounced muscle insertion for the pronator quadratus on the left and right ulnae.

Diagnosis: Normal variation in response to hypermuscularity (see Section 6.29).

Description
Mild bilateral midshaft osteosclerotic inflammation of the left and right tibiae.

Diagnosis: Mild periostitis as a result of a non-specific infection or possibly localized trauma (see Section 6.31).

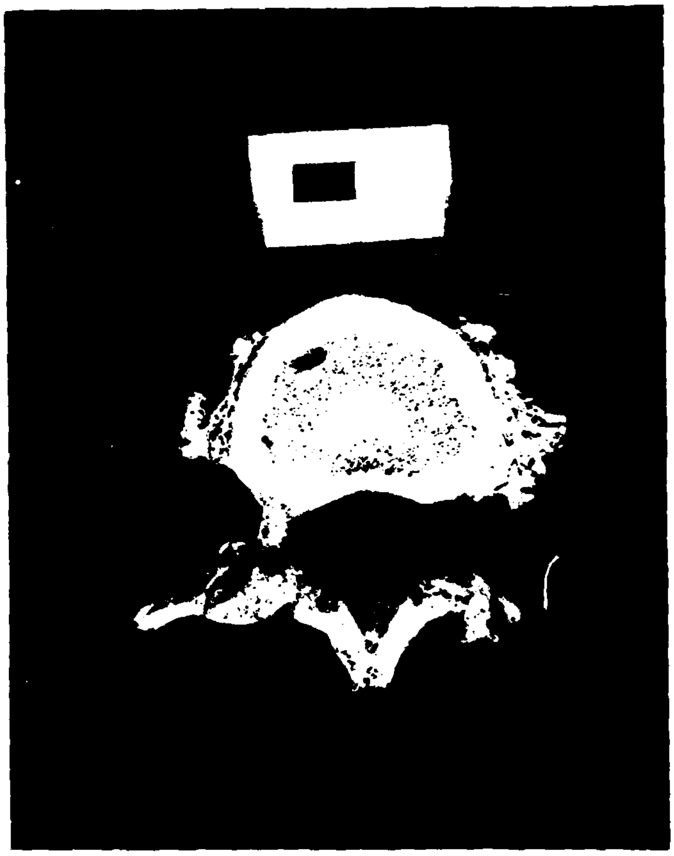


Figure 49 Vertebral osteophytosis of L5, Red Horse Hawk (39C034) (Exhibit A, Catalogue No 1.). Note the incomplete union of the neural arch.

Description

Presence of an ossified ligament on the popliteal line of the right tibia.

Diagnosis: Bone spur production in response to ligament injury (myositis ossificans) (see Section 6.27).

6.4 Anton Rygh Site (39CA4) - Exhibit B, Catalogue No. 2B

Description

Mild erosion of the articular surfaces of the left femur, left and right tibiae, and left and right tali (individual no. 2). Mild lipping of the articular surfaces of the left scapula, left and right calcanei, and right cuboid (individual no. 3).

Diagnosis: Mild degenerative joint disease.

Description

Extensive erosion and sclerous reactive tissue formation on the scapular articular surface of the left clavicle (individual no. 3).

Diagnosis: Severe degenerative joint disease with a probable trauma association.

Description

A weak periosteal reaction on the popliteal area of the posterior left femur, superior to the medial condyle (individual no. 2). This roughly circular osteosclerotic lesion is 15 mm in diameter.

Diagnosis: Mild inflammation of the medial head of the gastrocnemius muscle.

Description

Mild bilateral midshaft osteosclerotic inflammation of the left and right tibiae (individual no. 2).

Diagnosis: Mild periostitis of the left and right tibiae as a result of a non-specific infection or possibly localized trauma.

6.5 Sully Site (39SL4) - Exhibit C, Catalogue No. 3

Description

Spongy periosteal reaction along the midline of the calvarium including both parietals and the frontal (individual no. 1) (Figure 41).

Diagnosis: Possible metabolic reaction to iron deficiency anemia (see Section 6.30).

Description

Erosive pitting of the articular surface of the temporo-mandibular joint (individual no. 2).

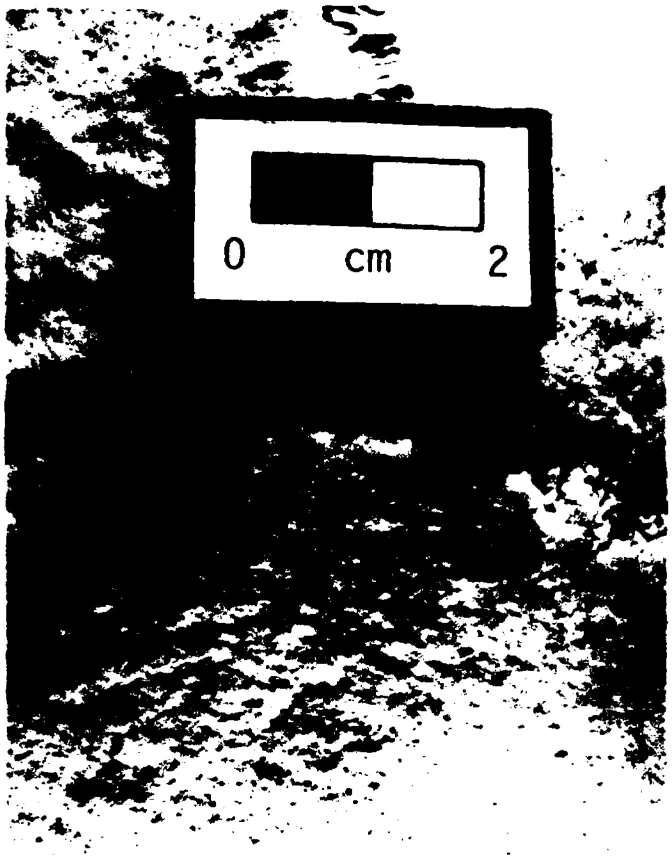


Figure 41. Spongy periosteal reaction, individual no. 1, Sully site (39SL4) (Exhibit C, Catalogue No. 3).

Diagnosis: Mild degenerative joint disease of the temporo-mandibular joint.

Description
Presence of four large lambdoid ossicles, left side (11.0 mm X 11.0 mm), right side (4.5 mm X 13.0 mm, 3.0 mm X 13.0 mm, 2.5 mm X 13.0 mm) (individual no. 2).

Diagnosis: Anomalous developmental variation of an undetermined origin (see Section 6.28).

6.6 Blue Blanket Recreation Area - Exhibit D, Catalogue No. 4

Description
Mild to moderate erosion of the articular surfaces of the proximal right humerus, distal left humerus, and proximal left and right femora.

Diagnosis: Mild to moderate degenerative joint disease.

Description
Mild osteophyte formation on L3 and L4 with body cavitation.

Diagnosis: Mild to moderate vertebral osteophytosis.

Description
Presence of an ossified ligament at the proximal fibular articular surface of the right tibia with the formation of an articular facet on the proximal-medial fibular shaft (Figure 42).

Diagnosis: Bone spur formation in response to localized injury of the attaching ligaments of the proximal fibula.

Description
Mild bilateral osteosclerotic inflammation of the left and right fibulae.

Diagnosis: Mild periostitis as a result of a non-specific infection or possibly localized trauma.

Description
Presence of a large lambdoid ossicle, left side (8.0 mm X 17.0 mm).

Diagnosis: Anomalous developmental variation of an undetermined origin.

6.7 Blue Blanket Recreation Area - Exhibit E, Catalogue No. 5

Description
Mild to moderate erosion of the articular surfaces of the proximal left humerus (w/lipping), proximal left radius, anterior acetabulum of the left innominate, head and medial condyle of the left femur, and right #5 metatarsal.

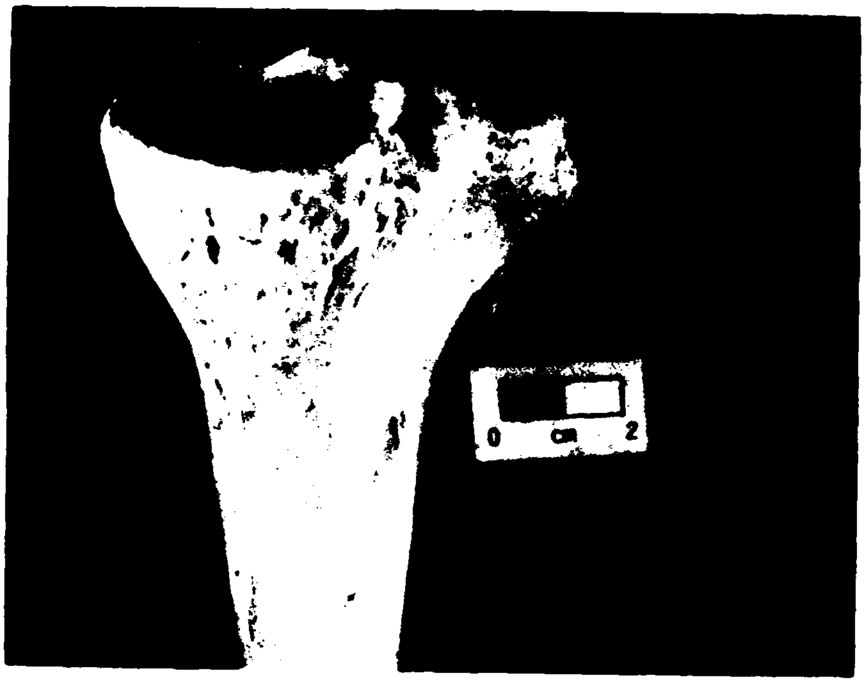


Figure 42. Bone spur, right tibia, Blue Blanket Recreation Area (Exhibit D, Catalogue No. 4).

Diagnosis: Mild to moderate degenerative joint disease.

Description
Ossified thyroid cartilage.

Diagnosis: Normal osseous response to aging.

Description
Moderate osteophyte formation with body cavitation of L2 through L5 and the first sacral vertebra.

Diagnosis: Moderate vertebral osteophytosis.

Description
Spongy periosteal reaction along the midline of the calvarium including both parietals and the frontal (Figure 43).

Diagnosis: Possible metabolic reaction to iron deficiency anemia.

Description
Presence of three large lambdoid ossicles, left side (13.0 mm X 22.0 mm), right side (7.8 mm X 15.1 mm, 13.7 mm X 18.5 mm).

Diagnosis: Anomalous developmental variation of an undetermined origin.

6.8 Mobridge Village (39WW1) - Exhibit G, Catalogue No. 7

Description
Moderate to severe erosion and lipping of the articular surfaces of the left and right scapula, sternal articulation left clavicle, distal left femur, proximal right femur, proximal left tibia, proximal right tibia (with eburnation), left cuboid, right talus, and distal left #1 metatarsal (individual no 2).

Diagnosis: Moderate to severe degenerative joint disease of the majority of load bearing joints.

Description
Moderate periosteal reaction on the shaft of the left fibula (individual no. 2).

Diagnosis: Inflammation due to an undetermined cause, although probably the result of local injury.

Description
Pitting on the dorsal pubis and preauricular sulcus of the left and right innominates (individual no 2) (Figure 44).

Diagnosis: Multiparous osseous changes (see Section 6.29).

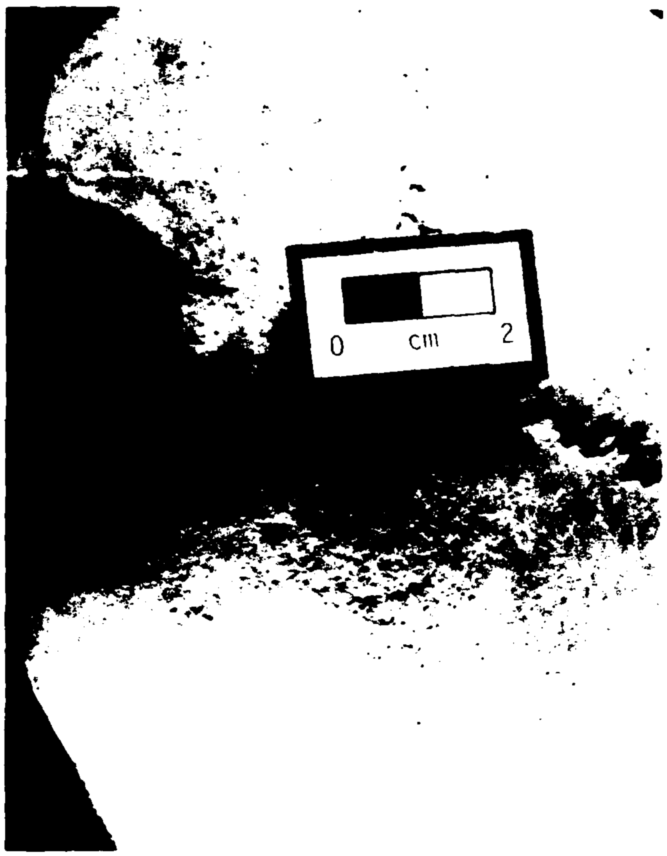


Figure 43. Spongy periosteal reaction, Blue Blanket Recreation Area (Exhibit F, Catalogue No. 5).

Figure 44. Multiparous osseous changes of the preauricular sulcus, individual no. 2, Mobridge Village (39WW1) (Exhibit G, Catalogue No. 7).

Description
Incipient fusion of the sacro-iliac articulation (individual no 2).

Diagnosis: Normal osseous response to aging.

Description
Sacralization of L5 (individual no 2).

Diagnosis: Anomalous developmental variation of an undetermined origin.

Description
Severe osteophyte formation on T12 and L1 through L5, with involvement of the articular surfaces (including T10) and incipient fusion of the bodies (individual no 2).

Diagnosis: Severe vertebral osteophytosis with degenerative joint disease of the articular surfaces.

Description
Presence of bilateral bone spurs on the left and right calcaneal tubercles (individual no 2) (Figure 45).

Diagnosis: Bone spur production in response to injury of the plantar ligament.

6.9 Howes Site (39HU203) - Exhibit H, Catalogue No. 8

Description
Mild erosion and lipping of the articular surfaces of the left and right scapulae and the sternal articulation of the right clavicle.

Diagnosis: Mild degenerative joint disease.

Description
Severe erosion of the left temporo-mandibular joint.

Diagnosis: Severe degenerative joint disease of the temporo-mandibular joint.

Description
Mild osteophyte formation on L5.

Diagnosis: Mild vertebral osteophytosis.

Description
Incomplete union of the neural arch of S3 through S5 (Figure 46).

Diagnosis: Spina bifida occulta (see Section 6.28).

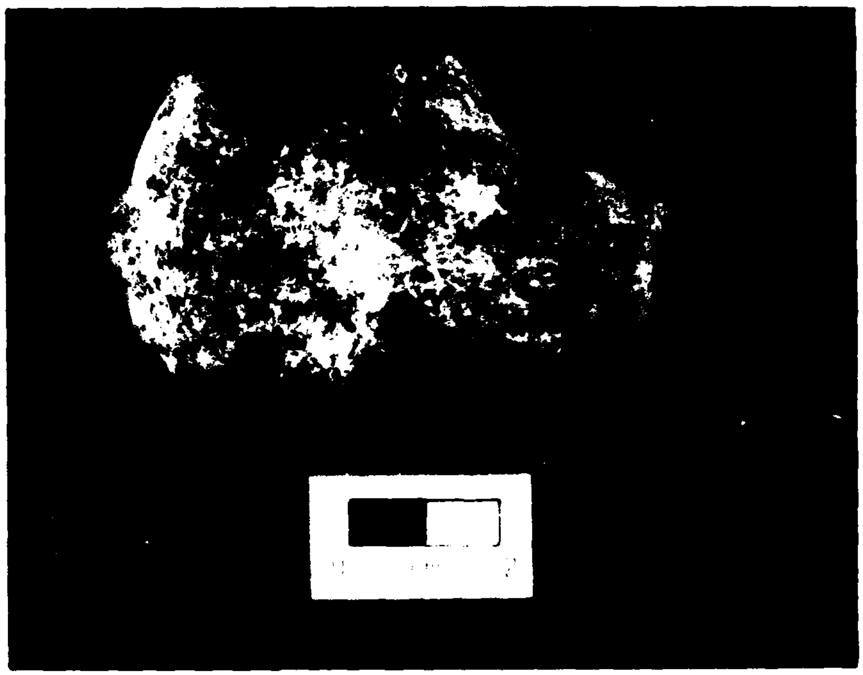


Figure 45. Bone spur on the calcaneal tubercle of the left calcaneus, individual no. 2, Mobridge Village (39WW1) (Exhibit G, Catalogue No. 7).

Figure 46. Spina bifida occulta, Howes site (39HU203) (Exhibit H, Catalogue No. 8).

6.10 Blue Blanket Point (39WW98) - Exhibit I, Catalogue No. 9/10

Description

Presence of a deep sulcus on the left humerus at the insertion of the teres major (individual no. 3).

Diagnosis: Normal anomalous variation as a result of hypermuscularity.

Description

Sinus abscess, right maxilla at M^2 (individual no. 4) (Figure 47).

Diagnosis: Secondary sinus involvement resulting from an apical abscess of rM^2.

Description

Mild erosion of the articular surfaces of the left and right temporo-mandibular joints, left and right scapulae, and proximal right radius (individual no. 4).

Diagnosis: Mild degenerative joint disease.

Description

Pitting on the dorsal pubis and preauricular sulcus of the left and right innominates (individual no 4).

Diagnosis: Multiparous osseous changes.

Description

A very weak periosteal osteosclerotic reaction on the posterior surface of the right femur at the popliteal region, superior to the medial condyle (individual no. 4). This roughly circular lesion is 15 mm in diameter.

Diagnosis: Mild inflammation of the medial head of the gastrocnemius muscle.

Description

Moderate erosion and lipping of the articular surfaces of the left and right scapulae, proximal left and right humeri, left and right radii, left acetabulum, and distal left femur (Figure 48) (individual no. 5).

Diagnosis: Moderate degenerative joint disease.

Description

Mild bilateral midshaft osteosclerotic inflammation of the left and right tibiae (individual no. 5).

Diagnosis: Mild bilateral nonspecific periostitis in response to either infection or possibly local injury.

Description

Presence of a bone spur on the medial surface of the proximal right fibula (individual no. 5).

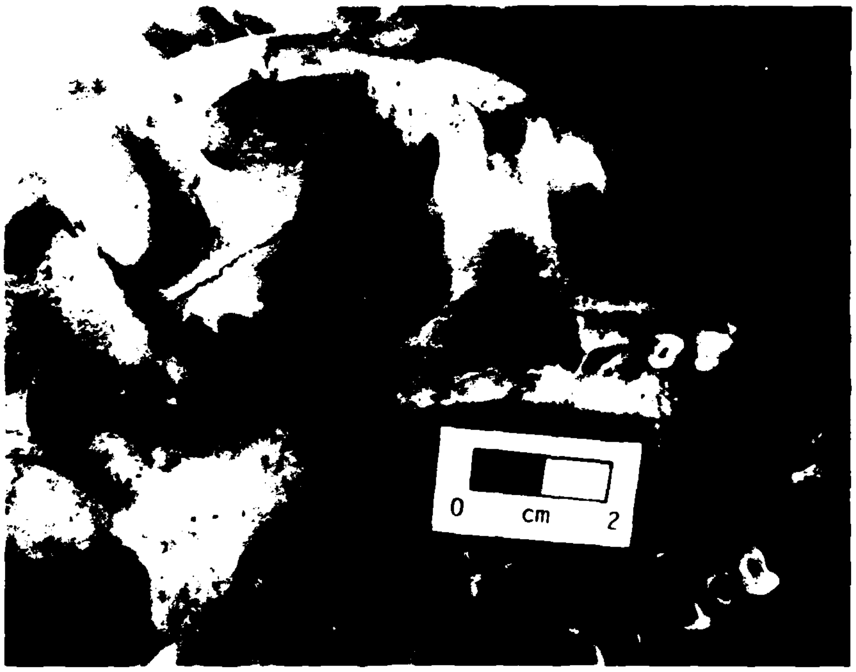


Figure 47. Sinus abscess resulting from an apical abscess of rM^2, individual no. 4, Blue Blanket Point (39WW98) (Exhibit I, Catalogue No. 9/10).

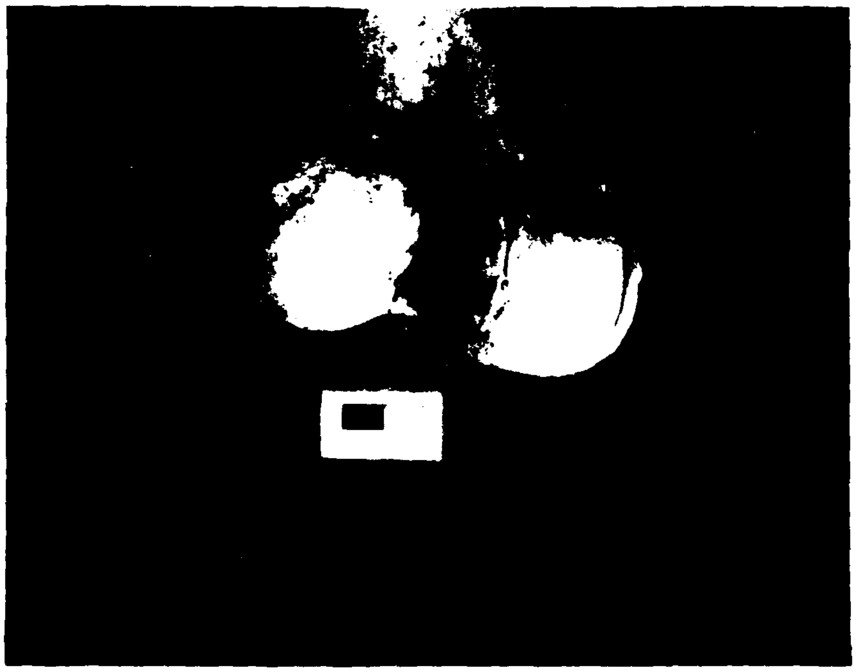


Figure 4. . Moderate degenerative joint disease, distal left femur, individual no. 4, Blue Blanket Point (39WW98) (Exhibit I, Catalogue No. [illegible]).

Diagnosis: An ossified ligament in response to local injury (myositis ossificans).

Description
A bifurcated left rib.

Diagnosis: Anomalous developmental variation of an undetermined origin.

Description
Ankylosis of two thoracic vertebrae (remainder of vertebral column is unaffected). There is no evidence of osteophytosis, nor of the "dripping candle wax" effect associated with ankylosing spondylitis. Ankylosis is complete posteriorly while only partially complete anteriorly. Disk space is still maintained. There is no evidence of a compression fracture or other traumatic injury.

Diagnosis: Anomalous developmental variation of an undetermined origin.

6.11 Blue Blanket Point (39WW98) - Exhibit J, Catalogue No. 11

Description
Spongy periosteal reaction along the midline of the calvarium including both parietals and the frontal.

Diagnosis: Possible metabolic reaction to iron deficiency anemia.

6.12 Pike Haven Recreation Area - Exhibit K, Catalogue No. 12

Description
Spongy periosteal reaction along the midline of the calvarium including both parietals and the frontal.

Diagnosis: Possible metabolic reaction to iron deficiency anemia.

6.13 Donahue Site (39LM27) - Exhibit L, Catalogue No. 13

Description
Spongy periosteal reaction along the midline of the posterior calvarium (individual no. 1).

Diagnosis: Possible metabolic reaction to iron deficiency anemia.

Description
Spongy periosteal reaction of the frontal bone at glabella (individual no. 2).

Diagnosis: Possible metabolic reaction to iron deficiency anemia.

6.14 Brush Creek Area - Exhibit M, Catalogue No. 14

Description

Low bone mass density.

Diagnosis: Senile osteoporosis.

Description

Moderate erosion and lipping of the articular surfaces of the proximal left and right ulnae, distal left and right humerus, proximal left and right radii, scapular articular surface of the right clavicle, costal articulations, acetabulum and auricular surface of the right innominate, right femur, left and right patellae, and phalanges (including eburnation).

Diagnosis: Moderate to severe systemic degenerative joint disease.

Description

Presence of two large lambdoid ossicles, left side (5.5 mm X 7.0 mm), right side (2.5 mm X 9.0 mm).

Diagnosis: Anomalous developmental variation of an undetermined origin.

6.15 Elm Creek Recreation Area - Exhibit N, Catalogue No. 15

Description

Moderate midshaft periosteal inflammation and cortical hypertrophy of a right tibia (n-8) (unassigned).

Diagnosis: Moderate non-specific periostitis in response to infection.

Description

Mild midshaft periosteal inflammation of a right tibia (n-9) (unassigned).

Diagnosis: Mild nonspecific periostitis in response to either infection or local injury.

6.16 Blue Blanket Point (39WW98) - Exhibit O, Catalogue No. 16

Description

Presence of a large lambdoid ossicle, left side (7.5 mm X 17.0 mm).

Diagnosis: Anomalous developmental variation of an undetermined origin.

6.17 Okobojo Point - Exhibit P, Catalogue No. 17

Description

Severe inflammation of the diaphyses of the left and right humeri, left and right radii, and left and right ulnae (full extent unknown due to poor preservation) (individual no. 1).

Diagnosis: Severe systemic periostitis/osteitis the result of a non-specific infection.

Description
Severe inflammation of the left and right tibiae (individual no. 2).

Diagnosis: Severe periostitis/osteitis the result of a non-specific infection.

6.18 39LM59 - Exhibit S, Catalogue No. 20A

Description
Mild erosion and lipping of the sacro-iliac articulation (individual no. 1).

Diagnosis: Mild degenerative joint disease.

Description
Mild osteophyte production on L2 through L5 (individual no. 1).

Diagnosis: Mild vertebral osteophytosis.

Description
Pitting on the dorsal pubis and preauricular sulcus of the left and right innominates (individual no 1).

Diagnosis: Multiparous osseous changes.

Description
A wedge-shaped second lumbar vertebra (Figure 49) (individual no. 1).

Diagnosis: Compression fracture (see Section 6.27).

Description
Partial ossification of the first costal cartilage (individual no. 2).

Diagnosis: Normal osseous response to aging.

Description
Mild erosion and lipping of the acetabular margin of the left innominate (individual no. 2).

Diagnosis: Mild degenerative joint disease.

Description
Moderate osteophyte formation and inflammation of the articular surfaces of C5 through T1 (unassigned).

Diagnosis: Moderate vertebral osteophytosis.

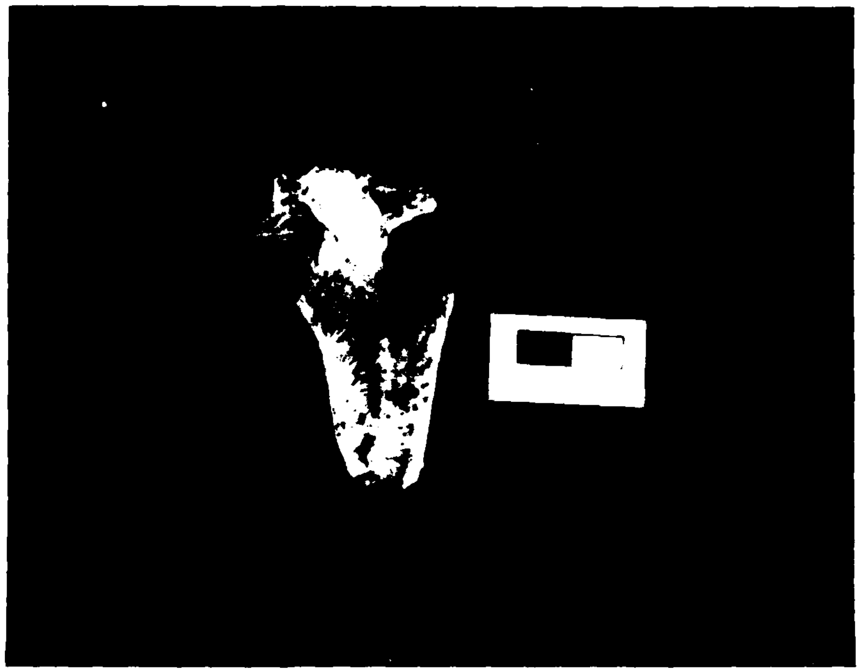


Figure 49. Wedge-shaped L2 resulting from a compression fracture, individual no. 1, 39LM59 (Exhibit S, Catalogue No. 20A).

6.19 Fort Lookout II (39LM57) - Exhibit T, Catalogue No. 20B

Description

Moderate to severe periosteal inflammation of the posterior shaft of a right femur (t-1) along the linea aspera and its periphery (unassigned).

Diagnosis: Inflammation resulting from injury to the muscles and ligaments that attach to the posterior femur.

6.20 39LM256 - Exhibit V, Catalogue No. 22

Description

Presence of two small button osteomas (ca 4 mm in diameter) on the skull; on the left parietal 45 mm lateral to the midline of the sagittal suture, on the right frontal 18 mm from the fronto-maxillary suture near the temporal line (individual no. 1) (Figure 50).

Diagnosis: Benign tumors of an undetermined origin (see Section 6.32).

Description

Incipient fusion of the sacro-iliac articulations of the left and right innominates (v-59 and v-60) (individual no. 1).

Diagnosis: Normal osseous response to aging.

Description

Flattened and distorted left and right temporo-mandibular joints. There is no evidence of erosion or osteophyte formation typical of degenerative joint disease.

Diagnosis: Probable dislocated mandible, with the formation of a new temporo-mandibular joint (individual no. 7).

Description

Presence of ten small button osteomas (3-4 mm in diameter) on the skull; three on the left and right parietals, seven on the frontal.

Diagnosis: Benign tumors of an undetermined origin.

Description

Differential femoral torsion; 45^{o} on the pair comprised of v-3 and v-9, and 0^{o} on the pair comprised of v-1 and v-4 (unassigned).

Diagnosis: Unknown anomalous variation, possible coxa vara.

Description

Severe osteophyte formation on an isolated C6 (unassigned).

Diagnosis: Severe vertebral osteophytosis.

Figure 50. Button osteoma, left parietal, individual no.1, (39LM256) (Exhibit V, Catalogue No. 22).

Description
Posteriorly displaced distal right radius (v-16) (Figure 51) in conjunction with severe erosion (with eburnation) of the head (unassigned).

Diagnosis: Well healed Colles' or pronation fracture with severe degenerative joint disease.

Description
Mild to moderate erosion and lipping of the articular surfaces of the proximal left femur (v-2), proximal right femur (v-4), and medial condyle of the right femur (v-9) (unassigned).

Diagnosis: Mild to moderate degenerative joint disease.

6.21 39BR13 - Exhibit X, Catalogue No. 25

Description
Incipient fusion of the sacro-iliac articulation of the right innominate (x-13) (individual no. 1).

Diagnosis: Normal osseous response to aging.

Description
Moderate erosion and lipping of the articular surfaces of the right radius (x-8) (individual no. 1).

Diagnosis: Moderate degenerative joint disease.

Description
Osteosclerotic reaction on the surface of the radial tuberosity of the right radius (x-8) (individual no. 1).

Diagnosis: Inflammation resulting from injury to the insertion of the biceps brachii.

Description
Spongy periosteal reaction along the midline of the calvarium, with bossing of the sagittal surface, including both parietals and the frontal (individual no. 2).

Diagnosis: *Possible metabolic reaction to iron deficiency anemia.*

Description
Bilateral periosteal reaction (osteosclerotic) on the posterior distal surface of the left and right tibiae (individual no. 2).

Diagnosis: Inflammation probably resulting from injury to posterior inferior tibio-fibular ligament.

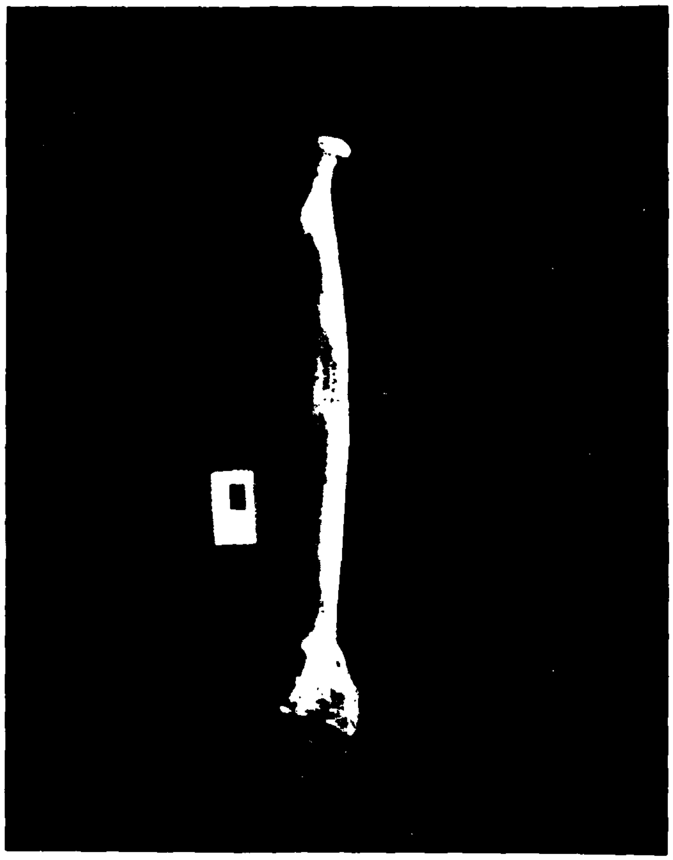


Figure 51. Healed Colles' fracture, right radius, 39LM256 (Exhibit V, Catalogue No. 22).

6.22 Exhibit X, Catalogue No. 26

Description
Spongy periosteal reaction along the midline of the calvarium including both parietals and the frontal (individual no. 1).

Diagnosis: Possible metabolic reaction to iron deficiency anemia.

Description
Presence of three large lambdoid ossicles, left side (14.0 mm X 27.0 mm), right side (13.5 mm X 21.0 mm, 10.5 mm X 18.0 mm).

Diagnosis: Anomalous developmental variation of an undetermined origin.

Description
Spongy periosteal reaction along the midline of the calvarium including both parietals and the frontal (individual no. 2).

Diagnosis: Possible metabolic reaction to iron deficiency anemia.

Description
Presence of a bifurcated digastric groove, right mastoid process (individual no. 2).

Diagnosis: Anomalous variation of undetermined origin.

6.23 Sunrise Hill Site (39CH210) - Exhibit Y, Catalogue No. 27

Description
Moderate midshaft periosteal inflammation of the right tibia.

Diagnosis: Moderate nonspecific periostitis in response to either infection or possibly local injury.

6.24 Walth Bay Site (39WW203) - Exhibit Z, Catalogue No. 28

Description
Presence of bilateral osteosclerotic scar tissue on the superior margin of the left and right orbits.

Diagnosis: Possible healed cribra orbitalia.

Description
Spongy periosteal reaction along the midline of the calvarium, with bossing of the sagittal surface, including both parietals and the frontal.

Diagnosis: Possible metabolic reaction to iron deficiency anemia.

6.25 Distribution

The identified anomalies and pathologies fall into seven descriptive categories (Table 20). These were tallied on a case by case basis, rather than by individual. This permitted the recording of cases that occurred among commingled remains where individual associations were impossible. Variations of the same anomaly/pathology when present in the same individual (i.e., degenerative arthritis and vertebral osteophytosis) were treated as a single occurrence instead of being recorded separately.

Not unexpectedly, trauma and arthritis were the most frequently observed and identified pathologic states. Acquired anomalies such as the osseous changes which accompany parturition were also common as were metabolic pathologies and developmental anomalies. Tumors were relatively infrequent.

6.26 Arthritic Inflammation

As is the case for prehistoric populations in general, arthritis was the most commonly identified single pathology. Fourteen individuals displayed either degenerative arthritis (degenerative joint disease or DJD) or vertebral osteophytosis (spondylitis deformans) (Gregg and Gregg 1987; Ortner and Putschar 1981; Steinbock 1976).

Seven individuals displayed some degree of vertebral osteophytosis. Vertebral osteophytosis is characterized by hypertrophic bone growth along the margins of the vertebral body in response to degeneration of the intervertebral disk. For these individuals the lumbar vertebrae were almost exclusively involved. The lumbar vertebrae are common locations for this form of arthritis, however, the underrepresentation of vertebrae among these samples may have altered the true distribution. Although some cases were severe no ankylosis was observed.

All fourteen individuals displayed some form of degenerative joint disease. Degenerative arthritis is a progressive breakdown of the joint articular cartilage. As the joint becomes inflamed, osteolytic activity (erosion and pitting) takes place over the center of the joint surface. At the same time osteophyte formation (lipping) takes place along the margin of the joint. This differential action causes the joint to degrade in the center and build up along the edges. In terminal stages of cartilage destruction, bone to bone contact is made and results in eburnation (polishing) of the articular surface. All levels of arthritic inflammation were encountered among these individuals. Eburnation and severe joint destruction was uncommon, however, and present in only two individuals and then only for single joints. Every major joint was affected. The most common being the load bearing joints of the shoulder, pelvis, knee, and elbow. Trauma may be considered a factor in the incidence of degenerative joint disease, but as with vertebral osteophytosis, aging is a more probable cause (Gregg and Gregg 1987).

Table 20. The distribution of anomalous and pathologic states.

Category	No. of Cases	Percentage
Arthritis	15	18.8
Trauma	15	18.8
Developmental Anomalies	13	16.2
Acquired Anomalies	13	16.2
Metabolic	11	13.8
Infection	10	12.5
Tumors	2	2.5

6.27 Trauma

Physical injury or trauma was another commonly observed disease category. Fifteen cases of trauma related pathology were identified. Seven of these (47%) (Table 21) involved localized periosteal inflammation. These osteosclerotic reactions are interpreted here as responses to injury of the surrounding tissue (i.e., muscle and ligaments) (Gregg and Gregg 1987; Ortner and Putschar 1981). Three were located on the posterior surface of the femur in the popliteal region that serves as an attachment for the medial head of the gastrocnemius muscle. This inflammation may be indicative of a Baker's cyst or bursitis of the bursa of the medial gastrocnemius and semimembranosus (Nisonson et al. 1984). Damage to the medial head of the gastrocnemius, and to the ligaments of the knee in general, occur when an excessive valgus or varus force is placed on the knee (King 1986). Typically this trauma is chronic in nature. Bursitis of the patellar ligament, "carpet layer's knee", was also observed (see Section 6.2)(Peterson and Renström 1986). Bone spurs are another response to tissue trauma. Here the body reacts to ligament or muscle tears by calcifying the inflamed tissue (Zimmerman and Kelley 1982). Four bone spurs were identified. Three of these involved the superior fibular articulation of the tibia (see Sections 6.3, 6.6, and 6.10). The fourth case involved bilateral bone spurs of the left and right calcaneal tubercles (see Section 6.8).

By comparison, the more serious forms of trauma, fractures and dislocations, were infrequent. Two probable dislocations were observed. The first involved an unresolved subluxation of the mandible (see Section 6.20). Here the temporo-mandibular joints were flattened indicating that the mandible had been anteriorly displaced. The second case involved two pairs of femora

Table 21. Trauma related periosteal reactions.

Individual	Location	Tissue Involvement
39CO34, Individual no. 1	popliteal region, left femur	gastrocnemius
	tibial tuberosity, right tibia	patellar ligament
39CA4, Individual no. 2	popliteal region, left femur	gastrocnemius
39WW98, Individual no. 4	popliteal region, right femur	gastrocnemius
39LM57, unassigned	posterior surface, right femur	see text
39BR13, Individual no. 1	radial tuberosity, right radius	biceps brachii
39BR13, Individual no.2	posterior distal surface, left and right tibiae	tibio-fibular ligament

from site 39LM256 (see Section 6.20). Here differential femoral torsion was observed. Although the cause of this phenomenon is still unknown, congenital coxa vara has been suggested (Hershkovitz et al. 1982). Two fractures were also observed. The first was a compression fracture of the second lumbar vertebra (see section 6.18). Osteoporosis as a cause was unlikely based on the overall density of the vertebral elements of this individual. This was supported by radiographic analysis which indicated normal bone density. The second fracture was of the variety known as a Colles' or pronation fracture (see Section 6.20) (Ortner and Putschar 1981). This trauma occurs when a person falls forward with the arms outstretched. In this case the fracture involved the distal right radius. Although fully healed there was significant posterior displacement of the distal radius with resulting distortion.

That seven of the fourteen cases of trauma (inflammation and bone spurs) involve the popliteal region suggests that the knee was highly vulnerable to injury among the various peoples represented by these remains. The cause of this injury is unknown but would appear to be in part due to extreme knee rotation possibly aggravated by squatting (Jurmain 1977; King 1986).

6.28 Developmental Anomalies

The growth process is influenced by both genetic and environmental factors. The metric and non-metric characteristics of the skeleton are therefore a combination of intrinsic and extrinsic components (Corruccini 1974; Grüneberg 1963; Ossenberg 1976). Twelve anomalous characteristics (Table 22) were identified as being developmental in nature, that is arising out of the growth process. Six of these (46%) involved the formation of large ossicles in the lambdoid suture. These are routinely scored as non-metric traits and as genetically based indicators of population affinity (cf., Anderson 1968; Berry

1979; Berry and Berry 1967; Ossenberg 1970, 1974, 1976). As Ossenberg (1970) has demonstrated, however, artificial cranial deformation, an environmental influence, increases the frequency of wormian bones in the posterior vault.

The spinal column served as the focus for five anomalies (38%). These ranged from lumbarization and sacralization to spina bifida occulta. Although the etiology of these varied anomalies is not the same there is evidence to suggest that some may form a complex of neural tube defects (Bennett 1972; Bradtmiller 1984). Here too, the separation of environmental and genetic factors is difficult. Spina bifida occulta, for example, is listed as a mendelian trait with dominant inheritance (McKusick 1978), with distinct population associations (Post 1966). At the same time, studies suggest that dietary zinc deficiency may be a contributing factor (Bergmann et al. 1980; Soltan and Jenkins 1982).

6.29 Acquired Anomalies

The human skeleton is a plastic structure. Through the differential action of the osteoblasts and osteoclasts bone can be remodelled in response to lifetime conditions, activities, aging, and non-disease stress. As an "osteobiography" (Saul 1976) the human skeleton records a variety of acquired anomalous characteristics. Because acquired characteristics are to a certain extent age and sex-dependent, their relative presence or absence will depend on the age and sex structure of the skeletal samples. In this series of skeletons acquired characteristics were common, taking three forms; aging responses, hypermuscularity, and osseous changes due to multiparity (Table 23). Anomalies relating to aging were of course a function of the number of older adults. This could be seen in the frequent ossification of cartilaginous connecting tissue in the later years, including one case involving the thyroid cartilage (see section 6.7). Identifying hypermuscularity is more subjective in that prehistoric skeletons are normally more robust than their industrialized counterparts. Those cases identified as resulting from hypermuscularity exhibited muscle markings beyond the normal range of variation.

Parturition is another acquired condition that regularly leaves behind a record of its presence. Through pregnancy related hormonal and traumatic changes in the ligaments that bind the pelvis together, pits are formed in the dorsal surface of the pubic bone and in the preauricular sulcus (Houghton 1974; Kelley 1979; Krogman and Iscan 1986; Putschar 1976; Suchey et al. 1979; Ullrich 1975). These osseous changes become more pronounced with each successive birth.

6.30 Metabolic Pathology

Unlike many pathologic states, those that are metabolic in nature are more subtle in appearance and therefore more difficult to identify. Nine individuals displayed osseous changes with a probable metabolic origin. All nine had a spongy periosteal reaction of the parietals and frontal bone. In two cases this also involved bossing of the parietals along the sagittal

Table 22. Developmental anomalies.

Individual	Anomaly
Red Horse Hawk (39CO34)	
	lumbarization of S1
	spondylolysis L3 and L5
Sully (39SL4) Individual No. 2	
	lambdoid ossicles
Bl. Blanket Rec. Area Ex. D	
	lambdoid ossicles
Bl. Blanket Rec. Area Ex. E	
	lambdoid ossicles
Mobridge (39WW1) Individual No. 2	
	sacralization L5
Howes (39HU203)	
	spina bifida occulta
Bl. Blanket Pt. (39WW98) Ex. I	
	bifurcated rib
	vertebral ankylosis
Brush Creek Area Ex. M	
	lambdoid ossicles
Bl. Blanket Pt. (39WW98) Ex. O	
	lambdoid ossicles
Exhibit X Individual No. 1	
	lambdoid ossicles
Exhibit X Individual No. 2	
	bifurcated digastric groove

Table 23. Acquired Anomalies.

Individual	Anomaly	Cause
Red Horse Hawk (39CO34)		
individual no. 1	ossified first costal cartilage	aging response
	incipient fusion sacro-iliac articulation	aging response
Anton Rygh (39CA4)		
individual no. 1	incipient fusion sacro-iliac articulation	aging response
	pronounced insertion for pronator quadratus	hypermuscularity
Mobridge (39WW1)		
individual no. 2	pitting of dorsal pubis/preauricular sulcus	multiparity
	incipient fusion sacro-iliac articulation	aging response
Bl. Blanket Pt. (39WW98)		
individual no. 3	pronounced insertion for teres major	hypermuscularity
Bl. Blanket Pt. (39WW98)		
individual no. 4	pitting of dorsal pubis/preauricular sulcus	multiparity
39LM59		
individual no. 1	pitting of dorsal pubis/preauricular sulcus	multiparity
39LM59		
individual no. 2	ossification of the first costal cartilage	aging response
39LM256		
individual no. 1	incipient fusion sacro-iliac articulation	aging response
39BR13		
individual no. 1	incipient fusion sacro-iliac articulation	aging response

suture. Similar porous pitting has been described as a manifestation of porotic hyperostosis (Gregg and Gregg 1987; Rose et al. 1984). The etiology of porotic hyperostosis is not fully known, and several diseases are implicated (El-Najjar 1976; Lallo et al. 1977; Mensforth et al. 1978). Of these, iron deficiency anemia is the most commonly identified cause (Steinbock 1976; Stuart-Macadam 1985, 1987). Porotic hyperostosis is a disease with three expressions; osteoporotic pitting, spongy hyperostosis, and cribra orbitalia (Lallo et al. 1977). All three manifestations include a hypertrophy of the cranial diploë combined with thinning of the cortical bone. The nine cases here are all identified as osteoporotic pitting. All are mild to moderate in expression. In addition to its external facies, porotic

hyperostosis is also characterized radiographically by a "hair on end" appearance in lateral exposures. The radiographs taken of intact crania were inconclusive (but suggestive of this hair on end form). Although there appeared to be some hypertrophy in the two cases with cranial bossing (see Sections 6.21 and 6.24). One individual (see Section 6.24) also displayed bilateral scar tissue on the superior margin of the orbits. While other causes exist, this scarring is consistent with healed cribra orbitalia.

6.31 Infection

Although evidence from the dentition (see Section 5.5) suggested that infectious/metabolic stress was a health factor, evidence of infection was present in only eight individuals. For seven of the eight this took the form of mild to moderate periostitis. In five cases the tibia was the locus of inflammation while in two cases it was the fibula. The lower legs are common foci for hematogenous infection leading to periostitis. This may be due to their low position in the circulatory system or to their cooler temperature through reduced surrounding tissue mass (Ortner and Putschar 1981). The majority of cases were mild and did not involve an increase in cortical thickness. Two cases were graded as moderate, one fibula and one tibia; the latter (see Section 6.15) also displayed hypertrophy of the cortex, a feature which was radiographically verified. In all seven cases the inflammation was non-specific and apparently localized. While "shin splints" and/or hematomas resulting from physical injury cannot be ruled out, the bilateral occurrence of three cases implies a systemic infectious origin. The final case of infection was found in a young juvenile (see Section 6.17). Although poor preservation hampered complete description, all of the long bone diaphyses displayed a severe periostitis/osteitis indicative of severe systemic infection.

6.32 Tumors

Neoplasms were rare among these individuals, as they are in larger skeletal samples (Gregg and Gregg 1987; Williams 1985a). Only two individuals showed evidence of bony growths. Both cases (see Section 6.20) involved small benign button osteomas. Button osteomas are small relatively common osteoblastic tumors of the outer cranial vault (Ortner and Putschar 1981:378). It may be significant that both cases came from the same burial location.

6.33 Harris' Lines

Not all anomalous and pathologic conditions are visible to the naked eye. One particular class of stress related features is only discernable through radiographic analysis. Harris' lines, or transverse lines, are radio-opaque lines which appear in radiographs of long bone diaphyses. Under conditions of severe stress, primarily of nutritional or infectious origin, bone growth can be halted (Steinbock 1976; Wells 1967). When growth resumes, in a manner analogous to the formation of enamel hypoplasias, a record of this growth cessation remains in the form of a thickened transverse layer of the

diaphysis. These lines are most often found on the tibia, with lesser incidence on the femur, radius, and metacarpals. Unfortunately, unlike enamel hypoplasias, Harris' lines are not permanent and can disappear through time due to remodelling. For this reason older adult bones less frequently display this trait. Also, Harris' lines only reflect stress during the growth years and have no application for adult stress.

The analysis of Harris' lines was hampered by the lack of intact juvenile and young adult long bones, especially the tibia. Only four individuals possessed long bones in a condition sufficient to permit analysis (see Appendix G). Antero-posterior exposures were made (5MAS, 56-60KV) of each of the elements. The results of this limited series of exposures were inconclusive. The radio-opaque lines that were observed were faint and difficult to distinguish from radiographic artifacts. Two of the four individuals did show what appear to be multiple transverse lines. In addition, a right tibia that was radiographed because it displayed severe periostitis (see sections 6.15 and 6.29) also showed what appear to be three very heavy transverse lines. Unfortunately only a single intact young adult tibia (see section 4.10) could be used to determine the age which the Harris' lines were formed. Following the procedure outlined by Clarke (1982) the location of the transverse lines was measured as a proportion of the total length. Comparing these distances against a precalculated table (Clarke 1982:80) produced ages of 3, 5, 6, 7.5, 8, and 9 years. These ages at which systemic stress possibly took place are consistent with those obtained from the analysis of enamel hypoplasias (see Section 5.5).

6.34 Stature

By itself, stature is simply another descriptive feature of skeletal biology. Like other developmentally dependent characteristics, stature is a reflection not only of an individual's genotype but the environment as well. A "secular growth trend" for stature among industrialized populations has long been recognized as the direct result of improvements in nutrition and health care. Conversely, where chronic stress exists, stature may be reduced below the genetic potential. Stature then may serve as another indicator of population stress. Willey (1982) in his analysis of the Crow Creek site (39BF11) found that stature for the Crow Creek inhabitants was shorter than that of later Arikara. Although other explanations exist, nutritional and infectious disease stress stand out as the most likely source of this difference.

Seven sexed adults had intact femora permitting the calculation of stature (Table 24). Unassociated (commingled) femora were not utilized as the uncertainties of sexing long bones outweighed any advantage gained from larger sample sizes. Six of the seven individuals for which stature was calculated come from sites of post-Woodland age. The seventh individual, recovered from 39BR13, could not be placed in any culture-historic framework. Compared with the average stature from northern Plains Woodland (Williams 1982a; 1985a, 1985c) and Arikara samples (Willey 1982) three of the four male stature estimates are shorter. Two of the three female stature estimates are exceptionally tall for both Woodland and Arikara, while the third is shorter

Table 24. Stature estimation in cm.

Individual	Sex	Stature
39C034 - individual no. 1	female	152.8 ± 3.8
39CA4 - individual no. 1	male	153.8 ± 3.4
Bl. Blanket Rec. - Exhibit D	male	165.9 ± 3.4
Bl. Blanket Rec. - Exhibit E	male	163.5 ± 3.4
39WW1 - individual no. 2	female	167.1 ± 3.8
39WW98 - individual no. 5	male	168.6 ± 3.4
39BR13 - individual no. 2	female	166.3 ± 3.8

than average. Unfortunately, these very small samples make it impossible to ascertain their significance.

7.0 PALEODIETARY ANALYSIS

7.1 Introduction

Paleodietary research is a new and still growing subarea of physical anthropology and bioarchaeology (cf., Buikstra and Cook 1980; DeNiro 1987; Gilbert 1977; Price et al. 1985; Sillen and Kavanaugh 1982). Using both osseous and non-osseous materials it is possible within certain limits to identify and reconstruct the primary components of prehistoric diets. Research to date has generally followed one of two lines of analysis. The first, and currently more popular, approach is the study of stable isotopes in bone tissue. As living tissue the human skeleton metabolizes organic dietary components. In addition to non-isotopic elements, a variety of stable non-radioactive isotopes are also incorporated into bone collagen. Two that have been studied in detail are C-13 and N-15 (DeNiro 1987). The ratio of C-13 to C-12 and of N-15 to N-14 in bone collagen is directly related to the type of plants utilized in the diet (Bender 1971; Osmond et al. 1973). These plants fall into one of three categories; legumes, non-leguminous C_3 plants, and CAM and C_4 plants. The ratio of the stable isotope to its non-isotopic form is know as δ and is represented as a percentage. The $\delta^{13}C$ divides plants into two non-overlapping categories. The first are the C_3 plants which utilize ribulose diphosphate in photosynthesis. The δ values range from -33% to -22%, with a mean of -27%. Those plants which use phosphoenolpyruvate carboxylase are known as C_4 plants have a δ of between -16% to -9% with a mean of -12.5%. Included in the first group are tuberous plants, nuts, and beans, while maize is an important member of the C_4 group. For this reason there is much interest in North and South America in the ability of the $\delta^{13}C$ to identify the use of maize in the diet (Bender et al. 1981; Buikstra and Cook 1980; DeNiro and Hastorf 1985; van der Merwe et al. 1981; Vogel and van der Merwe 1977).

By adding the $\delta^{15}N$, further differentiation of dietary components is possible (DeNiro 1987; DeNiro and Epstein 1981; Schoeninger et al. 1983). The nitrogen isotope is most useful in identifying the type of dietary animal protein, specifically terrestrial versus aquatic. Terrestrial mammals and feeders (including carnivores) have δ values ranging from 2% to 10%. While aquatic animals and feeders have δ's ranging from 10% to 25% (DeNiro and Epstein 1978; Schoeninger and DeNiro 1984; Schoeninger et al. 1983). Unlike C-13, which cleanly separates into distinct δ's based on plant type, N-15 δ's overlap to a certain degree. As a result interpretation is less certain. In general, δ values of 9% or less are indicative of terrestrial feeders and δ values greater than 15% are indicative of aquatic animals or feeders (Schoeninger and DeNiro 1984). Values that fall in between may involve one or both of these two components. In terms of prehistoric human diets the $\delta^{15}N$ can differentiate agricultural societies from those heavily dependent on marine resources.

The use of bone collagen C-13 and N-15 isotope levels has an inherent problem. Because these isotopes are metabolized from their original constituent food components, bone collagen concentrations vary depending on tissue type and trophic level. In a study using mice, DeNiro and Epstein (1978) found that whole body $\delta^{13}C$ values corresponded with diet, while body tissues showed an enrichment of 1%. In another study the bone collagen $\delta^{13}C$

of African ungulates showed an enrichment of 5.3% over the $\delta^{13}C$ of the plants they utilized (van der Merwe 1982). At the same time, trophic level appears to have little effect on C-13 enrichment. Carnivores have the same δ values as the animals they feed on. Nitrogen δ's also vary with tissue type, showing an average 1.4% enrichment (DeNiro and Epstein 1981). Unlike C-13 trophic level plays a role in N-15 tissue concentrations. For example, carnivores that feed off of legume consuming herbivores show higher $\delta^{15}N$ values than the legume consuming herbivore (Schoeninger and DeNiro 1984). Within rough limits N-15 isotope levels permit the identification of trophic level (i.e., primary vs. secondary consumer). As a result of isotope enrichment it is necessary to correct δ values when bone collagen is used as the source material. Correction values vary. DeNiro and Epstein suggest a 3.9% correction for the $\delta^{13}C$ (increased negativity) and a 2.4% decrease for $\delta^{15}N$. Van der Merwe (1982), on the other hand, recommends a 5.1% correction for $\delta^{13}C$ (van der Merwe et al. 1981, 1982).

More recently paleodietary research has begun to focus on another class of dietary components, trace elements. Of the 90 naturally occurring elements 26 are considered essential for animal life. Of these, 11 (carbon, hydrogen, oxygen, nitrogen, sulphur, calcium, phosphorous, sodium, chlorine, and magnesium) are present in large concentrations (> 0.01% body mass). The remaining 15 (iron, iodine, copper, manganese, zinc, cobalt, molybdenum, selenium, chromium, nickel, tin, silicon, vanadium, arsenic, and fluorine) are classified as trace elements (Gilbert 1977; Underwood 1977, 1981).

It is only within the past 20 years that the affects of trace minerals on human physiology have been fully recognized. Laboratory studies have shown that trace element deficiencies have subtle yet far reaching effects. Human studies have generally focused on five trace elements (zinc, copper, magnesium, iron, and iodine), all of which have reported naturally occurring deficiencies. Zinc deficiency, for example, has both prenatal and postnatal affects. Prenatally, fetal wastage can occur as well as severe developmental disturbances, including the possibility of spina bifida (Bergmann et al. 1980; Hurley 1979, 1981; Soltan and Jenkins 1982). Postnatal effects include severe dermatitis with secondary infection, skeletal growth reduction, and reduced immune response (Hambidge 1981; Hambidge et al. 1985; Underwood 1977; Walravens 1984). Copper deficiency is primarily a disease of infants, where it produces a wide range of clinical symptoms, including anemia and "scurvy-like" bone changes (Fell 1981; Underwood 1977, 1981). Low copper levels have also been observed in the two major malnutrition syndromes, kwashiorkor and marasmus. Iron deficiency anemia is another recognized trace element nutritional disturbance. Even where dietary trace element levels are adequate, nutritional requirements can be complicated by extrinsic factors. Copper, for example, reduces zinc absorption (Underwood 1977:206). Other dietary components also alter trace element absorption. The most notable of these is phytate, a common component of cereal grains. Phytate negatively affects both zinc and iron absorption. On the other hand, high animal protein diets are not only high in some trace elements such as zinc and iron, but they also aid in their absorption (Gilbert 1977; Hambidge 1981; Underwood 1977).

The role of diagenesis (postmortem depositional alteration) in trace element concentration is not yet fully known (DeNiro 1987; Kyle 1986; Sillen

and Kavanaugh 1982). It appears, however, that local soil conditions play a significant role in the enrichment or leaching trace and minor elements (Parker and Toots 1980). Lambert et al. (1983) found that Fe, Al, K, Mn, and possibly Mg are affected by soil contamination. Only zinc, strontium, and lead had the stability needed to be reliable for paleodietary research. Byrne and Parris (1987) had similar results, although their study found only zinc to be unaffected by diagenesis. A recent study by Klepinger et al. (1986) of bone cortex trace element content found that few elements showed a linear trend through time. Even if adequate controls have been made to account for soil levels of these elements, or other soil factors such as pH, results still may not be interpretable if the conditions that create them cannot be quantified. The degree of diagenetic change is also influenced by the bone tissue involved. Cancellous bone is more affected than compact bone and enamel. Lambert et al. (1982) also found ribs to be more affected by enrichment than femora, indicating that the bone chosen for analysis may be critical.

7.2 Stable Isotope Analysis

Nine bone collagen samples (Table 25) from nine burials (two samples each from 39CA4 and 39LM256) were analyzed for C-13 and N-15 levels (see Section 3.7 and Appendix I). The resulting δ's were calibrated using DeNiro and Epstein (1981:347) (Table 26). Following DeNiro (1987:190) a bivariate plot of $\delta^{13}C$ and $\delta^{15}N$ was produced (Figure 52). Seven samples form a fairly tight cluster. This plotting corresponds to a diet comprised of two primary components; terrestrial herbivores feeding on C_3 plants, and C_4 plants (i.e., Bison and maize). Five of the seven sites represented by these samples are assigned to the Village Tradition. For these six samples (two from 39CA4) the results correspond with the culture-historic association. The bone collagen radiocarbon date for the Howes site (39HU203) places this burial within the Woodland Tradition (see Section 4.9). Here the assumed dietary components are inconsistent with this culture-historic position. However, the radiocarbon date is in conflict with the Extended Coalescent component of this site. The two remaining samples come from site 39LM256, which has bone collagen radiocarbon dates placing these burials within the Middle to Late Woodland (see Section 4.23), the $\delta^{13}C$'s (-20.3% and -21.6%) are outside of the range for C_4 plants. If these values are accurate then they are consistent for this proposed culture-historic position (i.e., a diet utilizing terrestrial herbivores with little or no utilization of maize).

7.3 Trace Element Analysis

Nine bone samples (Table 25) were analyzed for trace and minor element content (see Section 3.7 and Appendix H). Due to burial conditions and preservation these samples did not fully correspond with the samples used for stable isotope analysis (i.e., 39LM256 and 39GR32). Seven elements (zinc, manganese, iron, magnesium, copper, strontium, and calcium) were targeted for study (see Table 27). The results were for the most part consistent for all nine samples and all seven elements. One problem encountered in interpreting these results is the lack of established human bone concentration standards.

Table 25. Stable isotope and trace element samples.

Sample	Stable Isotope	Trace Element
39CO34 - Individual no. 1	yes	yes
39CA4 - Individual no. 1	yes	yes
39CA4 - Individual no. 2	yes	yes
39HU203 - Individual no. 1	yes	yes
39LM59 - Individual no. 1 & 2[1]	yes	yes
39LM57 - unassigned adult	yes	yes
39GR32 - Individual no. 1	no	yes
39LM256 - unassigned adult	yes	no
39LM256 - unassigned adult	yes	no
39LM256 - unassigned adult	no	yes
39ST126 - Individual no. 1	yes	yes

[1]combined sample of both individuals

Strontium concentrations were all well above the minimum of 114 ug/gr. All but one magnesium sample (39ST126) were above the 1100 ug/gr minimum for bone tissue. The copper concentrations were problematic in that all were well below the identified bone level of 25 ug/gr (Harris 1983). While copper deficiencies do occur it seems improbable that every one of these diverse samples would be deficient. Considering that copper deficiency is primarily an infant disease, and that copper is readily available in a variety of foodstuffs, deficiency is unlikely (Underwood 1977). Other studies using prehistoric bone samples found similar low copper levels (Byrne and Parris 1987; Klepinger et al. 1986). The reason for these exceptionally low copper levels is unknown. While diagenesis is likely, Klepinger et al. (1986:327) suggest that copper may become volatile and be driven off during the preparation of the trace element sample.

Wide variations existed for iron concentrations, possibly reflecting whether or not bone marrow was present (Brätter et al. 1980). For the one low concentration (73 ug/gr,39ST126), iron deficiency cannot be ruled out (Prasad 1978). However, iron is subject to diagenetic contamination, and like copper may be lost during sample preparation (Klepinger et al. 1986; Lambert et al.

Table 26 Corrected C-13 and N-15 δ's.

Sample	C-13	N-15
39CO34	-16.1	7.7
39CA4 - sample no. 1	-17.6	7.3
39CA4 - sample no. 2	-16.6	7.0
39HU203	-16.4	6.4
39LM59	-17.4	6.8
39LM57	-15.8	6.5
39LM256 - sample no. 1	-20.3	7.6
39LM256 - sample no. 2	-21.6	7.2
39ST126	-15.1	6.1

1983. Manganese concentrations also varied considerably but apparently were within normal limits. It is the zinc concentrations that are the most intriguing from a nutritional standpoint. Based on normal bone zinc levels of 100-200 ug/gr, two of the nine samples are deficient, with a third one marginally sufficient (Hambidge et al. 1986). One sample in particular, 39GR32, had a zinc concentration of 52 ug/g indicative of severe zinc deficiency (P. Johnson, personal communication, 1987). Given the diagenetic stability of zinc, these results are considered reliable. They suggest that maize utilization may have had an affect on zinc bioavailability despite the high animal protein diet.

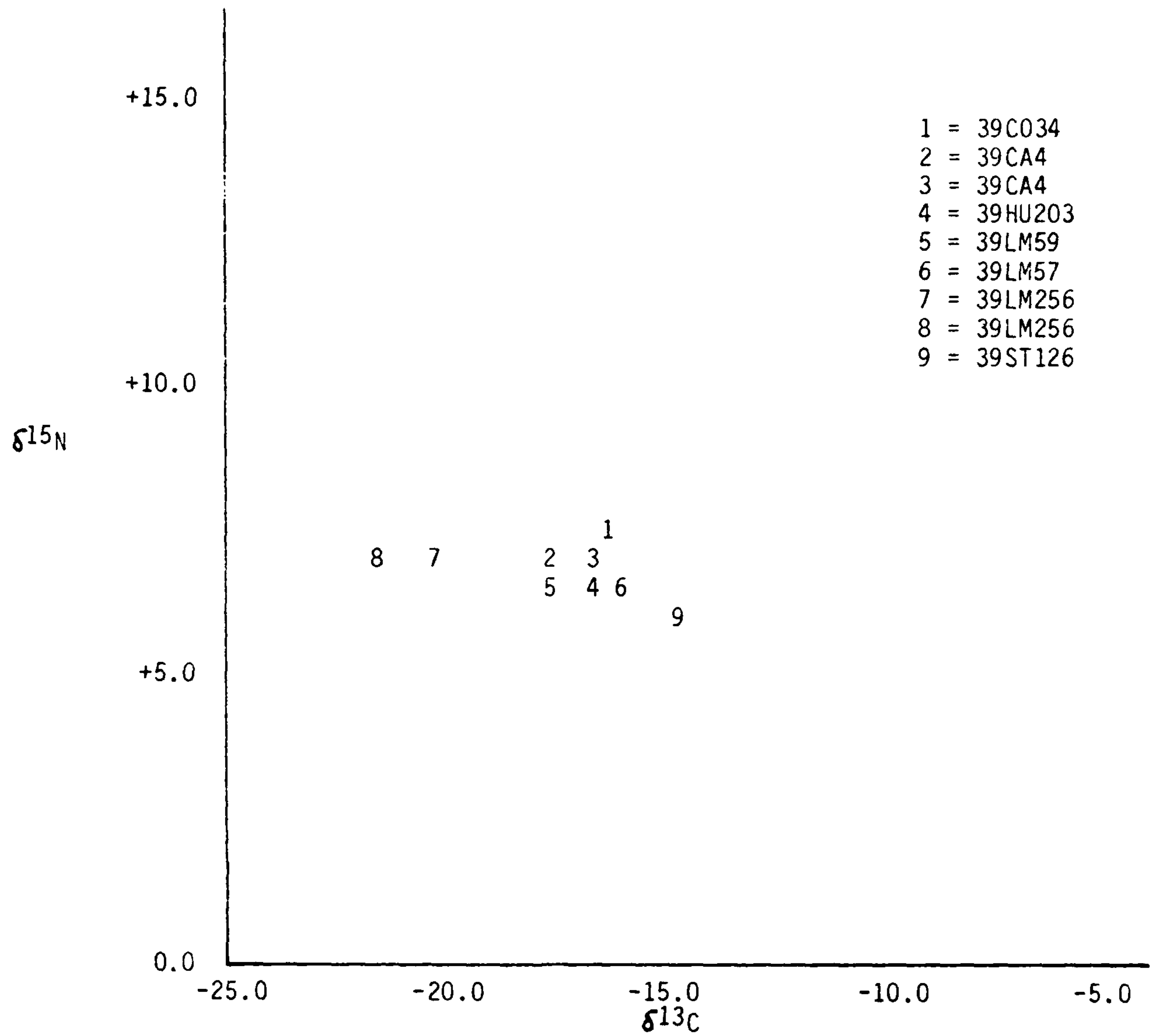


Figure 52. Bivariate plot of carbon and nitrogen isotope δ's.

Table 27. Trace element concentrations in ug/gr[1].

Sample	Zinc	Manganese	Iron	Magnesium	Copper	Strontium	Calcium[2]
39CO34	118 +/- 3	465 +/- 46	1192 +/- 1	4443 +/- 143	2.3 +/- 0.4	610 +/- 8	295 +/- 5
39CA4	228 +/- 7	300 +/- 39	1391 +/- 35	2958 +/- 252	1.8 +/- 0.2	449 +/- 52	271 +/- 2
39CA4	271 +/- 8	330 +/- 9	4239 +/- 1153	2312 +/- 78	4.1 +/- 0.4	201 +/- 22	293 +/- 40
39HU203	92 +/- 0	68 +/- 1	636 +/- 21	4079 +/- 117	3.3 +/- 0.1	518 +/- 5	340 +/- 7
39LM59	148 +/- 15	235 +/- 28	893 +/- 29	3894 +/- 614	6.0 +/- 0.8	692 +/- 28	303 +/- 14
39LM57	106 +/- 4	187 +/- 4	1288 +/- 16	2979 +/- 99	4.8 +/- 0.6	318 +/- 10	304 +/- 2
39GR32	52 +/- 0	139 +/- 8	2974 +/- 138	2321 +/- 82	5.8 +/- 0.1	390 +/- 0.4	341 +/- 5
39LM256	111 +/- 5	109 +/- 3	322 +/- 3	2822 +/- 118	5.2 +/- 0.3	356 +/- 30	309 +/- 9
39ST126	157 +/- 6	811 +/- 14	73 +/- 66	797 +/- 34	3.0 +/- 0.1	322 +/- 15	298 +/- 8

[1]values represent the mean and standard deviation of two analytical subsamples
[2]mg/gr

8.0 DESCRIPTION OF ARTIFACTS

Stanley A. Ahler

8.1 Methods

This chapter provides a description of all pottery, lithic flaking debris, and intentionally modified or shaped lithic and bone artifacts and any other materials, other than human skeletal remains and unmodified faunal remains, which occurred in the project samples. Modified lithic and bone artifacts were examined with a low power (X6.6 - X40) stereoscopic microscope for traces of residues, manufacturing wear, and use-wear. Lithic raw material types are identified according to Ahler (1977a) and Lovick (1980a). Stone tool functional and systemic context classes are according to Ahler (1975a, 1975b) and Lovick (1980a, 1980b). Flake class terminology follows Schneider (1972:93). Terminology regarding the technology of modified bone artifacts follows that in Moore (1985).

8.2 Red Horse Hawk (39CO34) - Exhibit A, Catalogue No. 1

Limonite Concretion Fragments (n=2)

Each specimen is predominantly yellow in color, but each appears to have been burned or exposed to heat, judging from the deep reddish color evident on one surface. (4.4 gm; 10.0 gm)

Unmodified Flaking Debris (n=3)

One specimen is a tertiary flake of Knife River flint (KRF), lamellar, blade-like in form with a faceted platform (0.7 gm). A second specimen is a secondary flake of burnt chalcedony/silicified wood (0.4 gm). The third is a primary flake of yellow/light brown chalcedony (4.6 gm).

Utilized Flake (n=1)

This is a tertiary flake of yellow/light brown chalcedony which exhibits unifacial utilization retouch along one lateral margin, adjoining the platform. The specimen is functionally classified as a flake tool used for cutting and scraping of variable materials (0.7 gm).

Body Sherds (n=7)

One sherd retains a remnant of the vessel neck as well as the shoulder area; the remaining six specimens are from locations lower on the vessel. Two exhibit heavy carbon encrustation (one exterior, one interior). All sherds exhibit smoothed exterior surface treatments. Mean maximum thickness is 5.93 mm for all seven specimens and 6.01 mm for the six largest, size grade 2 specimens. Total weight for all specimens is 44.6 gm. All sherds have relatively coarse crushed granite temper, exhibit minute surficial shrinkage cracks, are buff to grey in color, and are only moderately hard and well-fired.

Polished Bone Disk (n=1)

This specimen is heavily modified to a very flat, subrectangular (almost oval) outline, measuring 42.1 x 32.3 x 7.8 mm (7.8 gm) (Figure 53a). Thickness is quite uniform, and the lateral margins are very squared. Both flat faces exhibit numerous minute striations and heavy polish. No decoration or embellishment occurs. The specimen appears to have been cut from the central portion of a scapula of a large mammal, probably bison.

Microscopic examination reveals that the artifact perimeter was shaped by coarse abrasion, generally parallel to the edge axis. In a localized area along the broader end, striations perpendicular to the edge axis occur, along with polish, in two opposing beveled and faceted areas. This modification appears to be wear derived from use of the artifact as a scraping tool, held first with one face, then the other, toward the work. Alternately, this could be manufacturing wear, but its orientation is counter to that on the remainder of the artifact. The precise function of this specimen remains unclear.

Pointed Spatulate Rib Tool (n=1)

This is a complete specimen (Figure 53b) measuring 93.0 x 15.4 x 7.0 mm (10.4 gm). The specimen is fashioned from a split rib from a large unidentified mammal (probably bison). It exhibits cancellous tissue on one flat face and retains the exterior rib surface on the opposite face. It tapers to a blunt point on one end and is rounded and broadly blunt on the opposite end. The half of the specimen with the tapered point (the distal half) exhibits evidence of careful longitudinal scraping, apparently with a stone tool, to fashion the tapered tip. No polish from use or handling occurs on this half of the specimen. The tip at the tapered end is actually not acutely pointed, but rather is small, blunt, and rectangular in cross-section, measuring 0.8 x 2.4 mm at the tip. Both faces, and particularly, the lateral margins of the opposing proximal half of the specimen are heavily polished, probably from handling. The rounded, blunt end of the tool lacks polish but is heavily scarred, striated, and pitted. A small spot of unidentified black, apparently organic, residue occurs on the blunt end.

The morphology and use-wear on the blunt end of this specimen suggest that part of the tool was used for relatively heavy duty pressure flaking. The tapered, very small rectangular tip could have been used for delicate flaking, such as notching of arrowpoints, or could have been used for application of decorative incisions to pottery. The tapered end of the tool lacks the polish and acutely pointed tip expected from use as an awl or perforator. Alternate functions, such as quill flattener and pottery modeling tool, have been suggested in the literature (cf., Lehmer 1966:45-46) for blunt-ended, spatulate shaped rib tools.

Context, Comparisons, and Interpretations

As noted in the introductory discussion of the context of this exhibit (see Section 4.2), this burial was found in a location which had experienced cultural activity by villagers belonging to Extended Middle Missouri, Extended Coalescent, and Post-Contact Coalescent cultural variants. Thus, the culture-

historic association of this burial, even though apparently found within the confines of the Red Horse Hawk archeological site, is open to question. The associated artifacts may provide clues to that association.

The field report on this burial (Nowak 1985a) mentions only two of the 14 artifacts in the present collection. These are the pointed bone tool, noted as lying on top of the body, and the bone disk, noted as lying beneath the body. From this meager information it is possible that these are the only two items directly associated with the skeleton as grave furniture, and that the flakes, concretions, retouched flake, and body sherds have less direct associations, possibly occurring in the burial pit fill.

The two directly associated artifacts provide little information about the possible culture-historic affiliation of the burial. The pointed bone tool is a common artifact, occurring in virtually all village sites in the subarea in all time periods, and it is not culture-historically diagnostic. The bone disk may be slightly more informative. It is morphologically similar to disks or "game pieces", usually cut from the shafts of long bones, which are reported from several Middle Missouri tradition sites in North Dakota (e.g., Sperry 1968:71-72; Wood and Woolworth 1964:38; Wood 1967:91-92). Similar items seem to be absent from several large Coalescent variant assemblages from the Mobridge area (e.g., Baerreis and Dallman n.d.; Bass et al. 1971; Krause 1972). This would suggest a Middle Missouri tradition, and probably an Extended Middle Missouri variant association for this burial, although the evidence for this designation must be regarded as very tenuous.

The relatively dark color, coarse paste, and heavily smoothed surface treatment in the body sherds suggests that they are more likely derived from the Middle Missouri tradition than from the Coalescent tradition. The sherds are definitely coarser and distinct from sherds typically found in Extended Coalescent variant sites. The association between these sherds and the burial is unclear, at best. These sherds could be only inadvertent inclusions in the burial pit fill, potentially having any age as old or older than the burial event. None of the other artifacts with this burial (all lithic items) are of culture-historic significance.

It can be suggested that the two associated bone artifacts, the pointed implement and the bone disk, were everyday implements used by the woman buried at this location. The pointed rib tool could have been used alternately for decorating pottery and for resharpening end scrapers. The bone disk is a scraping tool, perhaps used to smooth the interior or exterior walls of pottery vessels during manufacture. Thus, the artifacts may reflect the tools of a person involved in pottery making and skin dressing, probably common tasks for many women in Plains Village societies.

8.3 Anton Rygh (39CO4) - Exhibit B, Catalogue No. 2B

Limonite Concretion Fragment (n=1)

This is a lump of yellow limonite concretion (10.7 gm) which exhibits no evidence of burning (no reddish discoloration). It may have served as a source

for yellow ochre, or, upon heating, red ochre. Red ochre was commonly used for body painting and hide painting in historic Plains Village societies (cf., Gilman and Schneider 1987:108, 197).

Worked Scapula Fragment (n=1)

This is a fragment of the axillary border of the left scapula of a large unidentified mammal, probably bison (length 169 mm, weight 48.4 gm). The distal end (opposite the glenoid cavity) is apparently squared off and the dorsal surface along the axillary margin has been removed by splitting. The entire surface of the specimen, including all fractures, is heavily rounded and smoothed. It appears to have been wave-washed along the shoreline. Judging by the form and degree of modification, it is probably a fragment from near the working end of a scapula hoe.

Context, Comparisons, and Interpretations

The disposition record for burial 2 at the Anton Rygh site (Nowak 1985a) indicates that no artifacts were observed in the burial pit or pit backfill. The origin of the existing specimens is therefore obscure, and any association between these artifacts and the skeletal remains is unclear (see Section 4.3). The waterworn condition of the worked scapula fragment suggests a fortuitous association between this artifact and the skeletal remains which were apparently removed from a burial pit.

The recovered artifacts offer no useful information about the culture-historic derivation of the skeleton.

8.4 Blue Blanket Point (39WW98) - Exhibit I, Catalogue No. 9/10

Modified Bird Bone Tubes (n=3)

One specimen is complete (use-phase class 3) and the remaining two are fragmentary. The complete specimen (Figure 53c) measures 70.4 x 13.6 x 10.0 mm in maximum dimensions (3.1 gm). It is made from the ulna of an unidentified large bird. The articular portions of the element have been cut off squarely and removed from each end. The transversely cut ends exhibit moderate smoothing and polish; the shaft surface is lightly polished. The function of this specimen is unknown.

The second specimen (Figure 53d) is a small fragment of one end of a transversely cut and smoothed bone tube which appears, from its size and shape, to be the matching element (an ulna, opposite side) from the same large bird represented by the previous artifact. The existing fragment, bordered by fresh fractures, is 22.8 mm in length (0.4 gm).

The third specimen (Figure 53e) is a short fragment of a transversely cut and smoothed, unidentified long bone diaphysis from a moderately large bird. One end of the specimen is intact, with both old and fresh fractures at the opposite end. Dimensions are ca. 28 mm long by 7.6 mm in diameter. The specimen is taxonomically unidentified, but the species involved is distinctly

smaller than that for the two previously described artifacts. The cut end is rounded, smoothed, and polished, and the shaft surface exhibits longitudinal scrape marks, striations, and smoothing. The function of the specimen is unknown.

Unmodified Flaking Debris (n=2)

Both specimens are tertiary flakes, and both are KRF. One specimen (1.3 gm) is a percussion struck bifacial thinning flake which exhibits pronounced smoothing and rounding on all dorsal flake ridges. This wear suggests that it was a sharpening flake struck from a relative large, heavily worn biface. The second specimen is lightly patinated and has the form of a microblade (27.0 x 9.5 x 2.3 mm, 0.7 gm). It exhibits no visible use-wear. It appears to be percussion struck from a core with a plain, unfaceted platform.

Unmodified Pebbles (n=7)

All are small waterworn pebbles (collective weight 18.2 gm). None appear to be artifacts.

Context, Comparisons, and Interpretations

The disposition records for this lot of human remains indicate that two brown chalcedony (KRF) flakes were recovered when some of the talus soil at the cutbank location was screened. Any direct association between the flakes and the skeletal remains is uncertain. The records mention nothing about recovery of the modified bird bone artifacts, and an association between these artifacts and the skeletal remains is unclear. The origin of the pebbles is equally unclear.

Even if one assumes that the artifacts were in direct association with the skeletal remains, little information on culture-historic association of the skeletons is offered (see Section 4.10). Bird bone tubes are an artifact form commonly associated with both Woodland period (Neuman 1975) cultures and virtually all Plains Villages groups in the Middle Missouri subarea. Knife River flint is a lithic type more commonly used by Woodland and Middle Missouri tradition populations in the region (Neuman 1975; Ahler 1977a; Johnson 1984), and these lithic items provide a very tenuous suggestion that the skeletal remains predate Coalescent period occupation of the region.

These skeletal remains were apparently recovered from very near the same location as that for Exhibit O, Catalogue No. 16 (see Sections 4.15 and 8.5). The comments on the culture-historic association of Exhibit O may therefore also apply to the present remains.

8.5 Blue Blanket Point (39WW98) - Exhibit O, Catalogue No. 16

Dentalium Shells (n=6)

These specimens are presumably shell beads or ornaments, although their very eroded condition precludes detection of evidence of modification or use-

wear. An identification as Dentalium sp. is indicated and a marine origin at one of the coasts is suggested, although a local fossil origin cannot be ruled out. The sample contains two larger specimens (Figure 53f) measuring 15.5 and 14.2 mm in length and having maximum diameters of 5.4 and 4.5 mm, respectively. All the smaller specimens appear to be reduced in size somewhat by recent fractures; all are less than 10 mm in length and have maximum diameters of 3.5 mm or less.

Shell Disk Bead (n=1)

This specimen (Figure 53g) was cut from the thick wall of a relatively large mollusk, probably a bivalve shell. It measures 7.8 mm in diameter by 3.7 mm thick, with a hole diameter of 3.4 mm. The drilled hole is not conical but has a constant diameter.

Flat Shell Ring (n=1)

This specimen (Figure 53h) has the form of a flat ring 21.6 mm in maximum diameter, 2.4 mm thick, and with a body width of ca. 3.5 mm. The central opening is ca. 14.6 mm in diameter. It is relatively flat in cross-section, having been cut from the body of a large bivalve or some other larger shell.

Mammal Bone Bead (n=1)

This specimen (Figure 53i) measures 12.0 mm long and ca. 4.7 mm in diameter. It was manufactured by the groove and snap method, having been cut from the diaphysis of a long bone, possibly a metacarpal or metatarsal, of an unidentified small mammal perhaps the size of a fox or coyote. The cut, snapped ends have not been ground, shaped or further smoothed, but remain jagged.

Wood or Bark Fragments

The collection from this locus includes a small jar containing several fragments of partially decomposed wood or bark. This may be the material identified in the field as cedar bark, although it appears too decomposed and fragmentary for reliable taxonomic identification. Weight is approximately 14 gm.

Context, Comparisons, Interpretation.

No information is available concerning the nature of the association between the artifacts described above and the skeletal remains, other than the mention that a sample of cedar bark cloth used for wrapping the skeletons was collected (see Sections 4.10, 4.16 and 8.4) (Kadlecek 1984). We must assume that these artifacts were somehow associated with the skeletal remains.

Dentalium shells and shell artifacts in general are relatively common in sites assigned to the Middle Missouri tradition in the subarea (e.g., Ahler 1977b:118; Sperry 1968:76-77; Wood 1967:96-98; Wood and Woolworth 1964:48) and such artifacts are decidedly less common in post-contact age Coalescent tradition sites (e.g., Lehmer 1971:161; Baerreis and Dallman n.d.:305-307;

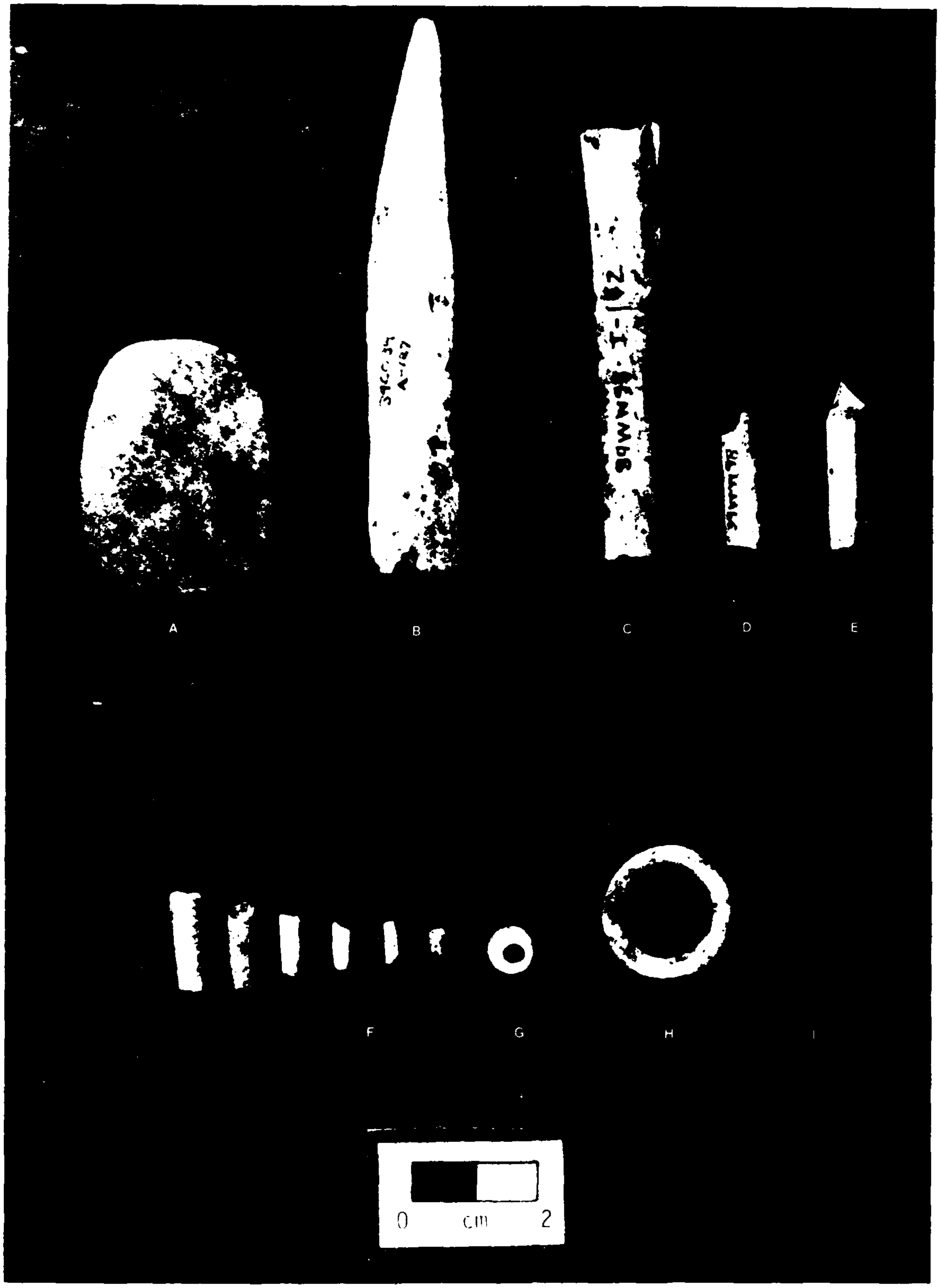


Figure 53. Artifacts recovered from Red Horse Hawk (39CO34) and Blue Blanket Point (39WW98). a: polished bone disk (39CO34), b: spatulate rib tool (39CO34), c: modified bone bird tube (39WW98), d: modified bone bird tube (39WW98), e: modified bone bird tube (39WW98), f: *Dentalium* shells (39WW98), g: shell disk bead (39WW98), h: flat shell ring (39WW98), i: mammal bone bead (39WW98).

Krause 1972; Bass et al. 1971). The flat shell ring is a rather unusual artifact form. Similar, generally larger specimens have been reported from some Middle Missouri tradition sites, for example, at Huff (Wood 1967:96-97) and Shermer (Sperry 1968:77). In addition, shell artifacts, including Dentalium, are relatively common in Woodland period burial mounds in the subarea (cf., Neuman 1975). These observations taken together suggest that the presumed associated skeletal materials are probably Woodland period or early Plains Village period (pre-Coalescent tradition) in age and association.

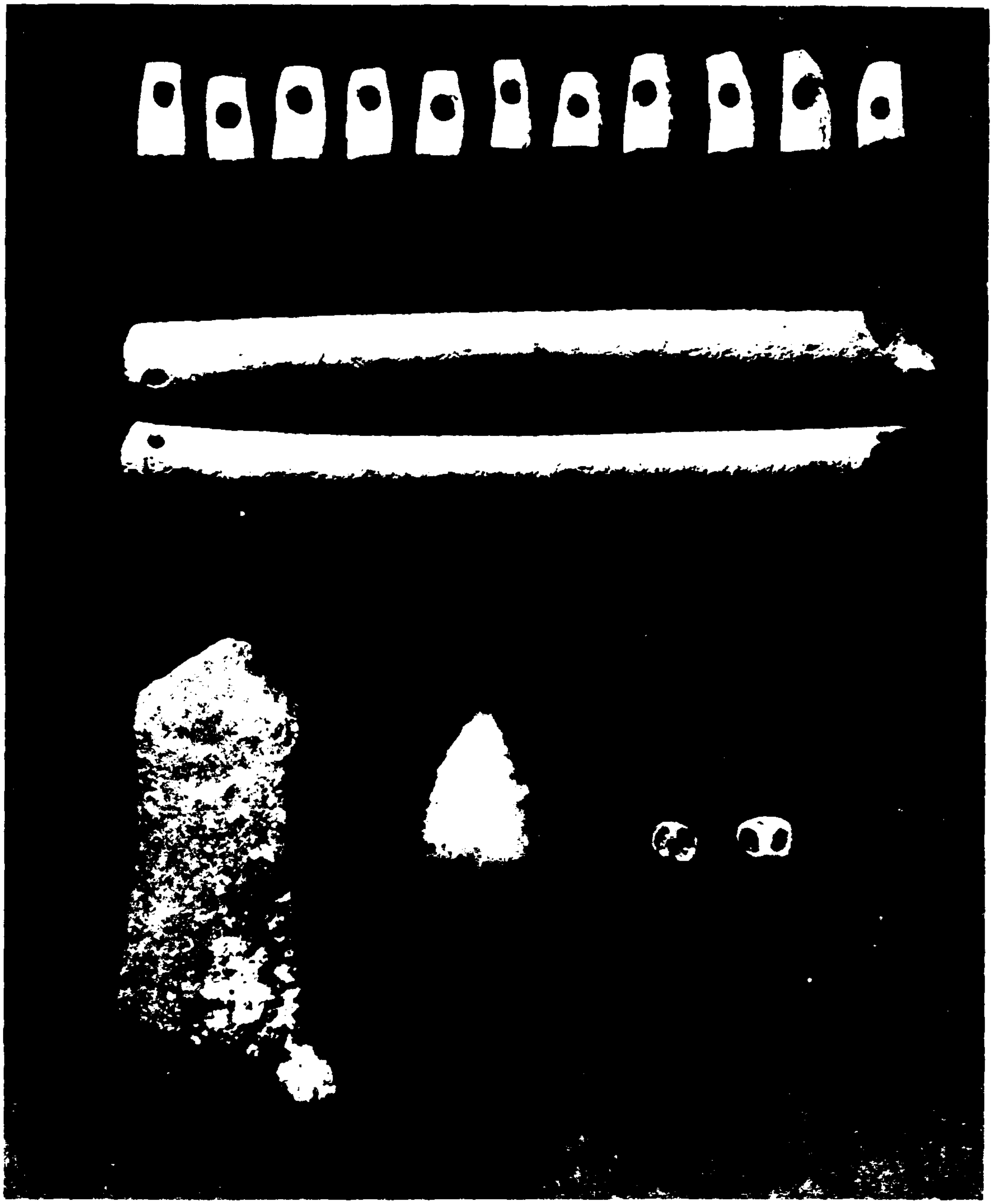
8.6 Okobojo Point - Exhibit P, Catalogue No. 17

Shaped and Perforated Teeth (n=85)

These specimens consist of the root portion of mammal teeth (apparently canine teeth or incisors) which have been extensively shaped and drilled for attachment or suspension (Figure 54a). Taxonomic identification of the specimens cannot be made with certainty due to the extensive modification which has altered the original form and which has completely removed the enameled portion of each tooth. Size and form indicate that all specimens could in fact be made from bison incisors, although the use of large human canines or upper incisors or incisors from large dogs or from other larger mammals cannot be ruled out. The specimens range in size from 17.7 x 9.3 x 6.8 mm to 12.4 x 6.3 x 4.2 mm. Collectively, the 85 specimens weigh 50.7 gm. Small parts of about three specimens are missing due to recent fractures.

With few exceptions the teeth are all modified in a very consistent manner and have an extremely similar form. The crown of the tooth has been completely removed and that end of the root is ground and abraded to a flat or nearly flat surface. In most cases that surface is perpendicular to the central axis of the tooth; in a few instances this ground surface is in a plane oriented ca. 65-75 degrees to the longitudinal axis of the tooth. In one instance, remnants of sawed grooves are visible at the wider end of the root, suggesting that the crown was removed in that case by the groove and snap technique. On all specimens the small tip of the root is also truncated by grinding to a flat or nearly flat surface. In addition to these modifications which truncate both ends of the tooth root, nearly all specimens are ground and/or scraped on opposing naturally flattened faces of the root in order to achieve a more accentuated flattened cross-sectional profile. This grinding may have been done for the purpose of exposing the inner matrix of the tooth, this being material of perhaps a slightly different color than the existing exterior surface. Finally, each tooth was perforated by rotary drilling with a stone bit into each flattened face, leaving an irregular biconical hole in all instances. One specimen exhibits a transversely cut groove or notch which is superimposed on the perforation in the center of one face.

The surfaces of many specimens are heavily eroded from the effects of plant root etching (Binford 1981:49-50). At least one-third of the specimens exhibit wear from the bindings which passed through the perforation. This wear consists of localized smoothing and polish and an indention on either lateral edge of the perforation hole; in nearly all cases, wear of equal intensity is observed at each edge of each orifice of the perforation, i.e., at two places



[illegible] 39LM256. a: perforated teeth ([illegible] Point), b: wing bone whistles ([illegible] Point), c: retouched flake tool (39LM58), d: small stone biface (39LM25[illegible]), e: modified gastropod shells (39LM256).

on each face. This wear pattern is not consistent with the specimens having been strung together on a single string or cord as beads. Rather, it suggests that each tooth was attached by at least two strings or cords to some other surface or object. Virtually all specimens exhibit staining by red ochre.

Bird Bone Whistles (n=2)

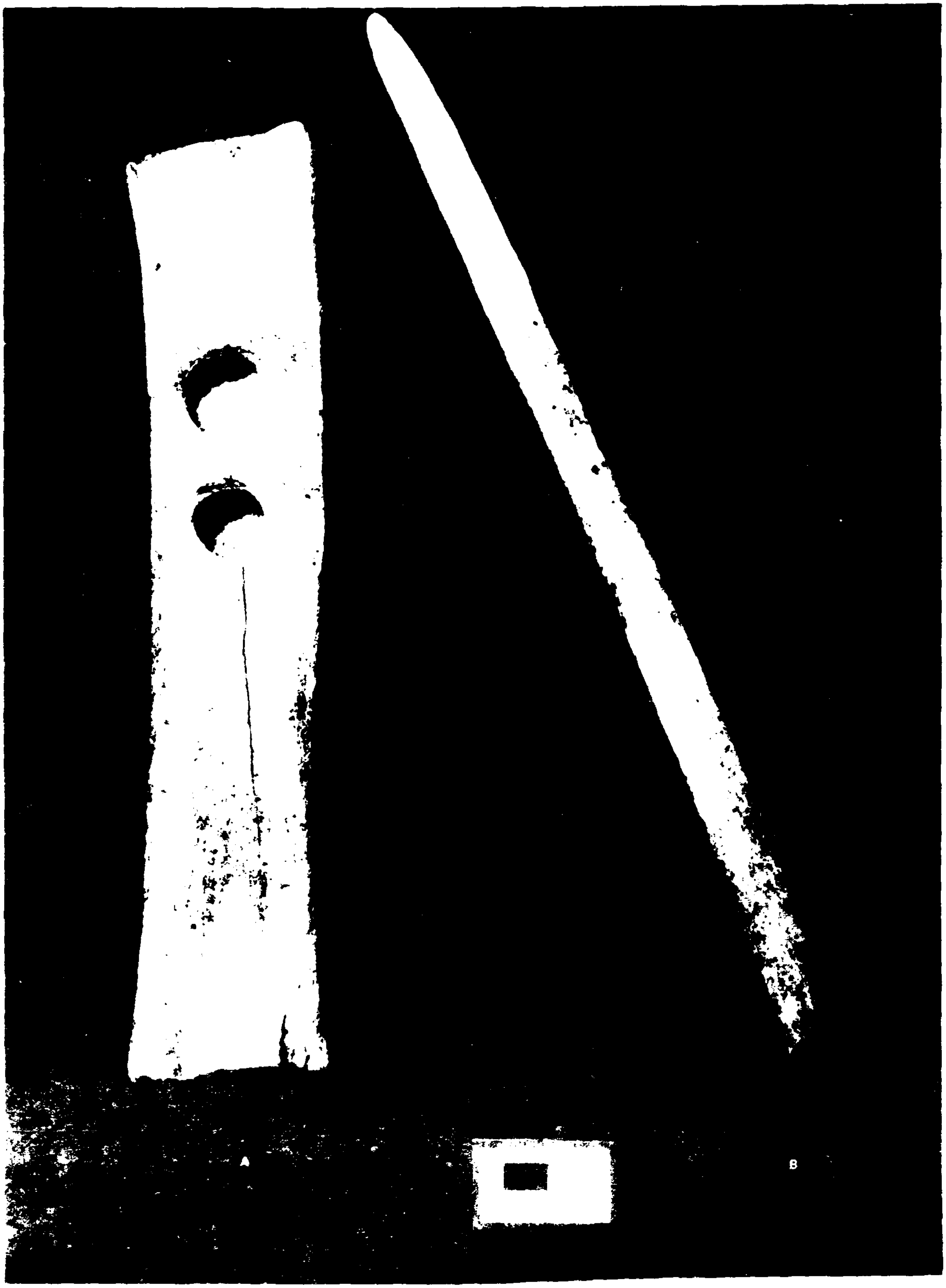
These specimens appear to be a matched pair of artifacts (Figure 54b) made from the diaphyses of opposing right and left ulnae of a large bird, possibly eagle. Each specimen is heavily modified and each exhibits a nearly identical fracture. The specimens are each about 10 mm in diameter and are 125 and 122 mm in length, respectively. Each weighs 7.1 gm. The intact end of each specimen is cut square to the long axis of the bone and is ground or rubbed smooth. A single small perforation is placed in the side wall about 3-4 mm from that end of each artifact. The opposite end of each specimen exhibits an old fracture which passed through an apparent wedge-shaped notch cut out of the shaft. The diagonally cut notch suggests that these items were whistles. Two small opposing perforations occur in the wall of the shaft just below the maximum indention of the notch. All these perforations are very small and delicate, being ca. 2-3 mm in diameter and conical in form. The surfaces of these artifacts are heavily etched from plant root action, but they appear to have been uniformly scraped and smoothed. Each retains a stain from red ochre.

Perforated Radius (n=1)

This artifact was made from the diaphysis of the left radius of a large mammal, likely a bison small in stature, but possibly a elk (Cervus elephas) (Figure 55a). Positive taxonomic identification is not possible due to the extent of modification. Dimensions are 219 x 47.5 x 31.4 mm (190.0 gm). Both articular ends of the radius have been removed and each end of the artifact exhibits a slightly irregular cut and smoothed margin approximately perpendicular to the long axis of the shaft. The body of the tool has been scraped and smoothed. Two large circular holes occur in the wall of the element; these are placed toward one end, proximal to the midpoint of the artifact. These holes have maximum diameters of 19.5 and 16.0 mm, respectively. The holes are placed in the flatter face of the radius, and a shallow transversely oriented indention, about the width of the hole, has been sawed or scraped out at the location of each hole. These holes have the appearance of being finger holes on a musical wind instrument, and the indentions appear to allow the placement of a portion of a finger completely across the hole. The interior of the opening at either end has been hollowed and smoothed slightly, apparently to remove some of the roughness of the interior cancellous tissue. Overall, the object has the appearance of a musical instrument. Its size and form also suggest the possibility of use as a sucking tube used by a shaman in curing ceremonies. No other modification directly indicative of attachment to other artifacts or tools, to form a more complex implement, is apparent. Stains from red ochre occur at various locations on the artifact.

Context, Associations, Interpretations:

The available information regarding the circumstances of recovery of the



[illegible] point [illegible] and [illegible]
[illegible] point), B: spatulate rib tool [illegible].

artifacts and skeletal materials indicate that these items were collected from the find location on two separate occasions (Church 1985:32). Detailed information regarding the association of the artifacts and skeletal remains is missing. Based on a lack of pottery at the find spot, a possible Woodland period or Archaic period age was suggested by the field investigator (Church 1985:32).

The artifacts themselves add little to this possible interpretation of the culture-historic association of the remains (see Section 4.17). The perforated teeth as well as the perforated radius are both unusual if not unique artifact forms which are not duplicated in the ethnographic and archaeological literature for the subarea examined by this author. The wear on the perforated teeth suggests that they may have been individually attached to a garment, much as perforated elk teeth are attached to women's dresses in several historic Plains Village cultures (e.g., Gilman and Schneider 1987:57, 167). The bird bone whistle is an artifact form which occurs consistently in low frequency in many Plains Village contexts varying in age from very early to very late (e.g., Bass et al. 1971:106-107; Caldwell and Jensen 1969:66; Falk et al. 1980:538-539; Wood and Woolworth 1964:38-39). Thus these artifacts offer little information on the likely cultural association of the skeletal materials. The advanced deterioration of the specimens, including the teeth, may suggest considerable age, perhaps greater than 200-300 years at the minimum.

8.7 39LM59 - Exhibit S, Catalogue No. 20A

Body Sherds (n=4)

Three specimens are size grade 2 in size (>1/2 inch), and the fourth is size grade 3 (<1/2 inch). The three larger sherds each exhibit fine cord-roughened exterior surface treatment. The smallest sherd has an indeterminate exterior surface treatment. The three grade 2 sherds have a mean maximum thickness of 5.1 mm. The total weight of the sherds is 17.2 gm. All specimens contain sparse crushed granite temper and are hard, compact, and well-fired.

Retouched Flake Tool (n=1)

This flake tool is manufactured on a large tertiary flake of Bijou Hills silicified sediment with dimensions of 74.8 x 32.4 x 8.7 mm (22.2 gm) (Figure 54c). The specimen appears to have been fractured transversely through the retouched margins (use-phase class 4). Each lateral margin is retouched unifacially in opposing directions, yielding a opposing beveled appearance to the tool. Microscopic examination reveals edge blunting and irregular flaking on both margins, suggesting use to saw and slice hard materials such as bone.

Charcoal Fragments (n=2)

Size grade 3 (>1/4,<1/2 inch). Weight 0.3 gm.

Context, Comparisons, Interpretations

The description of the excavation at this location discusses the remains of two and possibly three individuals in a large undercut pit (Winham 1983:16). Notations on the bags for some of the artifacts provide clues as to their association with the skeletal remains. Such notes indicate that one cord-roughened sherd was found with the burial behind the front burial, i.e., with the lower rear burial. Another sherd occurred in burial fill, and a third was recovered from the burial profile. The field report (Winham 1983:16) indicates that a quartzite flake was found next to the pelvis of the upper burial. This presumably is the retouched flake described here. Charcoal flecks were noted as occurring throughout the pit fill. The nature of the artifacts suggests that all items are inadvertent inclusions in the pit fill rather than intentional burial furniture (see Section 4.20).

Lehmer (1971:64) identified site 39LM59 as having an Initial Middle Missouri variant component. Winham and Lueck (1984:105) note the presence of Great Oasis ceramics at the site and concur with Lehmer's assessment of the culture-historic placement of the location. The occurrence of cord-roughened body sherds in the present collection is compatible with that interpretation and suggests that the skeletal remains are likely Initial Middle Missouri variant in derivation. The occurrence of a Bijou Hills silicified sediment tool in the pit fill is also compatible with that interpretation, this being a lithic raw material type used more often by Middle Missouri tradition peoples than by Coalescent tradition peoples (Ahler 1977a).

8.8 39LM256 - Exhibit V, Catalogue No. 22

Small Stone Biface (n=1)

This is a small, patterned triangular biface manufactured by pressure flaking (Figure 54d). The unstraightened lateral edges and irregular basal margin and basal corners suggest that it is an unfinished triangular arrowpoint, interrupted during manufacture. It is made of clear/grey chalcedony which does not appear to have been heat treated. Dimensions are 31.4 x 19.7 x 3.7 mm (2.2 gm). Microscopic examination reveals light rounding and smoothing on one lateral margin, concentrated particularly along one basal corner, and moderate rounding and smoothing of interior flake ridges on both faces. One spot of rock polish occurs on one face. The facial wear suggests that the specimen had in fact been extensively used or handled prior to deposition, and the localized edge wear suggests use for cutting relatively soft materials.

Modified Scapula Fragment (n=1)

This is a fragment of the blade of a scapula of a large mammal which measures 59.3 x 26.7 x 2.6 mm (3.4 gm). Old fractures comprise more than half of the margin of the specimen. The longest unfractured margin exhibits extensive scraping on both faces to produce a very sharp and acute edge. This specimen appears to be a portion of a scapula cutting tool, commonly referred to as a "squash knife" in the subarea literature (Gilman and Schneider

1987:62; Lehmer 1971:91; Wilson 1917:106).

Modified Gastropod Shells (n=2)

These are two thick-walled, freshwater snail shells (?Anculosa sp.) (Figure 54e) which have been modified by grinding away one-third to one-half of the body whorl of the shell on the aperture side. Grinding occurs in a plane parallel to the central columella in order to produce openings aside the columella for stringing or attachment as a bead or ornament.

Pointed Spatulate Rib Tool (n=1)

This is an unusually long bone tool made from the split rib of a large mammal, probably bison (Figure 55b). Maximum dimensions are 317 x 14.2 x 6.1 mm (31.9 gm). The artifact is strongly curved, with the cancellous face on the interior of the curve. Cancellous tissue has been ground or scraped smooth, and lateral edges of the tool have been extensively shaped by transversely oriented coarse abrasion which has left rasp or file-like marks. The lateral margins have not been subsequently smoothed. One end is rounded and blunt, while the opposite end is tapered to a blunt point having a slightly oval cross-section near the tip. Microscopic examination reveals light polish overall, apparently from handling, with polish being more accentuated within 20 mm or so of the tapered tip. The tapered tip itself exhibits a few deep transverse striations or indentions which retain embedded fragments of an unidentified, dark crystalline material. The blunt end of the tool is heavily pitted and scarred in its immediate center.

Wear on the blunt end of the tool is consistent with use as a pressure flaking implement. The polish and smoothing on the pointed end indicate contact with relatively soft material while the embedded residues indicate possible contact with stone or mineral substances. Use of the tapered tip for pressure flaking cannot be ruled out entirely, with the polish possibly coming from incidental contact with a pad used to back the pressure flaked stone tool. Longitudinal scarring and striations predicted to occur from pressure flaking are, however, absent on the shaft near the tapered tip. Use of the tapered end for something other than or in addition to pressure flaking is considered likely. The great length of this specimen suggests that it is a relatively little-used version of morphologically similar but shorter, heavily used and sharpened spatulate tools commonly found in refuse in Plains Village sites.

Context, Comparisons, Interpretation

The field report for the excavation at this location (Winham 1983:15) states that the only recovered artifact was the pointed rib tool. The origin for the remainder of the artifacts (biface, shell beads, and worked scapula) remains obscure, but it is possible that these items were removed from the pit fill surrounding the skeletal remains.

The artifacts described here offer little firm information on the culture-historic placement of the skeletal remains (see Section 4.23). The rib tool is a common artifact in Plains Village cultures of all ages, as is

the scapula cutting tool. Anculosa shells and shell beads are common in archeological sites along large river drainages in the lower midwest and midsouth (e.g., Webb and DeJarnette 1942). The occurrence of two ?Anculosa beads in the present context indicates little about culture-historic placement except perhaps to suggest a cultural group having trade contact with regions southeast of the site locality.

The field report (Winham 1983:10) notes the occurrence of a metal nail in an ash lens directly above the pit containing the burials, but fieldwork did not demonstrate the relationship between this ash lens and the pit. A post-contact age therefore cannot be assumed for the pit contents. Winham and Lueck (1984:174) suggest that the ash lens is later that the burial pit, further suggesting that the site contains both a late historic (reservation period) component and unidentified earlier component(s).

8.9 39ST126 - Exhibit W, Catalogue No. 23

Limonite Concretion Fragments (n=2)

Neither specimen exhibits discoloration from burning. Weight 2.5 gm.

Context, Comparisons, Interpretation

The noted possible artifacts offer no basis for inferences about the culture-historic derivations of the skeletal remains (see Section 4.24).

8.10 39BR13 - Exhibit X, Catalogue No. 25

Scapula Hoe Fragment (n=1)

This specimen is a fragment of the axillary border of a right scapula of an unidentified large mammal, probably bison. Fractures are old. The dorsal face of the axillary border has apparently been intentionally removed by splitting. The modified but unfractured edges and surfaces are heavily polished, and the distal end is heavily rounded. The specimen is thought to be a fragment from near the working end of a scapula digging implement.

Context, Comparisons, Interpretation

No information is available regarding the nature of the association between the artifact and the human skeletal remains (see Section 4.25). The scapula hoe offers no assistance in determining the culture-historic derivation for the skeletal remains.

9.0 FAUNAL ANALYSIS

Cherie Haury-Artz

9.1 Methods

The collections of non-human bone and shell from each site which lacked patterned modification were examined and as many elements as possible were identified to the nearest taxonomic level. Whenever possible the identifications presented here are based on comparative material housed at the Departments of Anthropology and Biology at the University of North Dakota. Cranial specimens of most mammals common in North Dakota are available in these collections along with complete examples of bison (adult and fetal), pronghorn antelope, white tail and mule deer, bobcat, bear, striped skunk, weasel, jack rabbit, cottontail rabbit, thirteen-lined ground squirrel, beaver, badger, martin, coyote, and a few small rodents. A very limited sample of bird skeletons, one snapping turtle (Cleydra serpentina), and no fish are available. In the absence of comparative material, identifications are based on information and illustrations provided in published references (e.g., Brown and Gustafson 1979; Cvancara 1970, 1983; Gilbert 1979; Olsen 1960, 1964, 1979) and unpublished keys in the possession of the author. Identifications are as specific as possible depending upon available materials. Malacology specialist Dr. Alan Cvancara, University of North Dakota, Department of Geology, was consulted for confirmation of identifications of mussel and snail shells.

All of the material, regardless of whether or not it could be identified, was examined for evidence of human modification and post-depositional damage. Record was made of the presence or absence of spiral fractures, butchering marks, burning, and rodent or carnivore gnawing. Butchering marks are classified according to descriptions found in current archeological literature (e.g., Binford 1978:23-25, 1980:96-147; Frison 1970:8-30; Weltfish 1965:218-219; Wheat 1979:62-71). These include cut marks (resulting from both filleting and dismembering), chop marks inflicted by direct percussion, and specialized splitting of elements to expose the marrow cavity.

The extent to which these specimens have been exposed to weathering was documented by classifying each according to the overall condition of the surface. Elements classified as unweathered are those on which the original surface is intact. Slightly weathered bones exhibit slight damage to the original surface such as root etching, but are still generally intact. On moderately weathered elements the surface is dry and exhibits longitudinal cracking. Approximately 25 to 50% of the original surface has been damaged or destroyed. Severely weathered elements exhibit deep horizontal and longitudinal cracks and/or surface exfoliation. More than 50% of the original surface of these materials has been obliterated.

9.2 The Red Horse Hawk Site (39CO34) - Exhibit A, Catalogue No. 1

The assemblage of faunal material from 39CO34 contains 18 elements. A total of seven of these are identifiable. The unidentifiable material is all

mammal bone. Five of these are elongate splinters which exhibit spiral fractures along all of the broken edges. This type of fracture results from breakage of the elements while they are relatively fresh or "green". Once the element has dried out fractures exhibit straighter edges and rough rather than smooth surfaces. Spiral fractures may result from bone breakage associated with human butchering and bone processing activities; however, they can also be produced by carnivore gnawing and accidental breakage (Binford 1981:51-60; Bonnichsen 1973). One fragment of a rib from a large sized mammal is present. Both ends of this element are broken with spiral fractures. These are interpreted as having resulted from human activity. An impact point from which one of the fractures originated is visible on one end (cf., Binford 1981:155). Seven short, light cut marks also appear near the lower margin of the exterior surface. These types of marks are associated with filleting meat from bone (Binford 1981:137; Wheat 1979:67-68). The remaining unidentifiable specimens include four pieces of vertebra from medium to large sized mammals and a small thin fragment of a skull. None of these elements exhibit evidence of human modification.

Three of the unidentifiable elements exhibit evidence of slight weathering and the remainder are unweathered. This indicates limited exposure to the elements and implies that the bones were buried rather rapidly and had not been disinterred very long prior to their collection.

Identifiable material includes large mammal, fish, and fresh water mussel shell (Table 28). The majority of the elements represent articular ends of three large bison limb bones; the distal and proximal ends of a femur, the distal end of a humerus, and the distal end of a radius/ulna. All of these are from the left side of mature animals (MNI=1). Each of these is described below.

The distal end of a left femur is from a large, mature bison. The diaphysis of this element is broken 7 cm above the trochlea with spiral fractures. No butchering marks were observed.

The proximal end of a left femur is also from a large, mature bison and may be part of the same element as the distal segment described above. The diaphysis is broken 9 cm below the trochanter minor and the top of the trochanter major has been broken away. Short, light cut marks are visible along, and perpendicular to, the trochanteric ridge. These probably result from cutting tendons and muscle in the process of disarticulating the joint. With the exception of some exfoliation near the broken diaphysis the element is in good condition.

The distal end of a left humerus is from a mature individual. The diaphysis of this element is broken with spiral fractures 8 cm above the top of the fossa on the lateral condyle. Light cut marks are visible along the distal surface of the medial condyle. These are placed on the anterior surface near the muscle attachments and are oblique to the edge. Again, these probably result from disarticulation of the joint. The element exhibits slight exfoliation near the broken edge, otherwise it is in good condition.

Table 28. Identifiable bone from 39CO34.

Taxa	Element	Side	Completeness	Age	Human Modification
Ictalaurus furcatus(?)	dorsal spine	na	complete	indet.	absent
Bison bison	femur	left	distal end	mature	spiral fractures
Bison bison	femur	left	proximal end	mature	cut marks
Bison bison	humerus	left	distal end	mature	spiral fractures, cut marks
Bison bison	radius/ulna	left	distal end	mature	spiral fractures
Lampsilis siliquoidea	valve	right	complete	indet.	absent
Ligumia recta latissima	valve	left	complete	indet.	absent

The fourth mammal element is the distal end of a left radius-ulna from a mature bison. The diaphysis of this element is broken with spiral fractures 15 cm above the lateral base. No evidence of butchering or weathering were observed.

A single fish element was recovered. This is the dorsal spine of a catfish (Ictalaurus). Using a key, the species is tentatively identified as I. furcatus. The element is relatively small. Its length is 4.6 cm and the basal width is 0.7 cm. It is unweathered and no evidence of human modification was observed.

Two fresh water mussel valves (family Pisidiiae) are also included in this assemblage. Identification of these elements to genus and species is based on a published key (Cvancara 1970). The first specimen is the right valve of a female Lampsilis radiata also known as a "Fat Mucket" (Cvancara 1970:11). The second specimen is a left valve tentatively identified as Ligumia recta latissima or "Black Sand Shell" (Cvancara 1970:10). Both of these species commonly inhabit large and small rivers and streams and may be found in lakes as well (Cvancara 1983:43-45). The Black Sand Shell, however,is not reported from the Missouri River drainage. Its range is generally farther to the east between Pennsylvania and Minnesota, a few specimens have been collected in the Red and Sheyenne Rivers of eastern North Dakota. These are considered to be in the western extreme of the range (Cvancara 1983:44-45; Alan Cvancara, personal communication, 1987). The presence of this specimen as far west as the Missouri River drainage suggests that it may have been culturally introduced at this site. It may indicate trade or other associations with eastern groups. Both valves are dry and weathered but intact, showing no

evidence of cultural modification.

9.3 Anton Rygh (39CA4) - Exhibit B, Catalogue No. 2B

This element is a medial portion of the dorsal spine from a left Bison bison scapula. Porosity and lipping along the edge of the spine indicate the presence of arthritis or other degenerative bone disease, suggesting that the animal was of advanced age. The surface of the bone is heavily weathered, exhibiting longitudinal cracking, root etching, and extensive crumbling along the broken margins. These features suggest that the element was either exposed on the surface or very shallowly buried for an extended period of time. No evidence of butchering or other forms of human modification were observed; however, these may have been obliterated by the weathering of the bone surface.

9.4 Blue Blanket Recreation Area - Exhibit D, Catalogue No.4

The faunal assemblage from the Blue Blanket Recreation Area contains 12 pieces of bone. Only two of these elements could be identified.

Two sections of broken bone from this group could be mended to form a portion of the ventral side of the proximal end of a left bison (Bison bison) metacarpal. The breaks which split this element are irregular and crumbly indicating that breakage is probably a post-depositional phenomenon. No evidence of human modification was recognized on this element. Six additional long bone fragments in this group exhibit similar physical properties and also may be parts of this metacarpal. These, however, could not be mended. No butchering marks were present on these fragments.

Four other unidentifiable pieces of bone are included in this group. One is a medial portion of a rib from a large mammal. One end of this element is broken with spiral fractures while the other exhibits a recent break. This element is slightly weathered, exhibiting root etching and some longitudinal cracks. No butchering marks were identified.

The remaining unidentifiable bone in this group includes a portion of a long bone which has been broken by spiral fractures and two small miscellaneous fragments which exhibit dry crumbly breaks. Evidence of butchering was not observed on any of these pieces.

9.5 Mobridge Site (39WW1) - Exhibit G, Catalogue No. 7

Eight fragments of mammal bone from the Mobridge Site (39WW1) were examined for this study. This assemblage includes four unidentifiable fragments of moderately to severely weathered bone. One of these is a medial section of a rib from a medium to large size mammal. This element is severely weathered, exhibiting deep longitudinal and transverse cracks and an eroded surface. The remaining elements are all miscellaneous fragments. One of these appears to have been broken by spiral fractures. Except for this

possible evidence of human modification, no evidence of butchering or bone processing was observed.

A fifth element, a proximal ulna fragment from a dog sized mammal, is also included in this assemblage. Unfortunately it is too weathered and fragmentary for further identification. No evidence of human modification was observed.

Three identifiable elements are also present. These are all identified as bison (Bison bison). Included are two foot elements and one tooth. All are from mature individuals indicating a MNI of 1. These elements are described individually below.

The first element is a complete second phalanx from a mature bison. No butchering is evident on this specimen; however, the surface is severely weathered and such evidence may have been obliterated.

The second distal limb element is a left astragalus from a mature bison. This element is complete and the surface is very severely weathered. No butchering marks were observed.

The third bison element is a lower left first molar. The crown height is 4 cm high; wear includes the surface of the crown and the labial style. This wear suggests a young but physically mature individual. Moderate weathering is evident in the vertical cracks in the enamel.

9.6 Blue Blanket Point (39WW98) - Exhibit I, Catalogue No. 9/10

The faunal remains from Blue Blanket Point include portions of fresh water mussel shell and two small bone fragments. The shell fragments appear to be parts of a single right valve of a fresh water mussel, family Pisidiiae. The total of all of the available fragments do not make up the complete element. The morphology of the beak and hinge area suggests that it belongs to the genus Lampsilis and is probably also L. radiata (Cvancara 1970:10; Alan Cvancara, personal communication, 1987). The two bone fragments are sections of hollow long bones from which articular ends have been removed. One appears to be a leg element of a wading bird, however, specimen identification is not possible.

9.7 Elm Creek Recreation Area - Exhibit N, Catalogue No.15

The assemblage from the Elm Creek Recreation Area contains only three bone fragments. These cross mend to form the dorsal face of a right proximal bison metatarsal (Bison bison). The element appears to be from a mature individual. It is severely weathered and the breakage is recent. These factors suggest that the element had been exposed on the surface for some time before it was collected. No butchering marks or spiral fractures could be identified on the element.

9.8 Okobojo Point - Exhibit P, Catalogue No.17

The assemblage from Okobojo Point includes 10 bone elements. One of these is a small unidentifiable splinter of mammal bone broken with spiral fractures. This element shows slight weathering in the form of root etching.

The remaining nine specimens are toad elements (Bufo). Included are three ilia, one humerus, one urostyle, and four long bone fragments. The three ilia represent two individuals (MNI=2), one paired set and a left ilium from a smaller individual. Both of these creatures belong to the taxonomic group Americanus. None of these elements exhibit any evidence of weathering or cultural modification.

It is unlikely that these toad elements represent culturally introduced fauna; rather, they are probably post-depositional site intrusions. Toads of the group Americanus inhabit rocky situations in open woods or woodland edges areas, shunning open grasslands and meadows (Collins 1974:47). It can be suggested therefore, that a gallery forest or other woodland situation existed at the time that these elements were deposited. Unfortunately, the provenience of these specimens is not sufficiently clear to determine if they are directly associated with the cultural use of the site.

9.9 Fort Lookout II Site (39LM57) - Exhibit T, Catalogue No. 20B

Twelve fragments of mammal bone make up the assemblage of bone from the Fort Lookout II site (39LM57). One of these is the posterior portion of a large rodent skull. It is not weathered and does not exhibit evidence of human modification. While it is possible that a medium sized rodent such as this might have been captured for food, it is more probable that the creature is intrusive. Burrowing rodents are often attracted to cultural sites because of the availability of food in midden deposits and the ease of digging in the loose, organic soil. The relatively fresh appearance of this skull and the absence of evidence of human modification suggests that the element is intrusive rather than cultural.

The remaining 11 specimens in this assemblage are miscellaneous unidentifiable fragments. Six of these are skull fragments and may be part of the rodent skull discussed above. All of these appear to be slightly weathered and none exhibit evidence of human modification.

9.10 39LM256 - Exhibit V, Catalogue No. 22

A single rodent element is the only bone in the faunal collection from site 39LM256. This element is the left femur of a juvenile Cricetine (mouse). The distal epiphysis is unfused and missing from the specimen. In the absence of comparative material further identification is not possible. This element is unweathered and unmodified and probably is a recent site intrusion.

One heavily eroded conispiral snail shell is also included in this faunal assemblage. It is so thoroughly eroded that taxonomic identification is not

possible; however, the thickness of the shell and its general morphology suggest that it is a fossil, probably of Tertiary age (Alan Cvancara, personal communication, 1987). The age of this specimen, along with its depositional context, suggests that it was intentionally collected by the inhabitants of the site. The extensive erosion of the surface makes it impossible to determine whether or not the shell has been modified.

9.11 Sunrise Hill Site (39CH210) - Exhibit Y, Catalogue No.26

A single fragment of unidentifiable bone from the Sunrise Hill site (39CH210) is present. This element is a piece of a weathered flat bone 1.4 cm long and 1.5 cm wide. No evidence of human modification is apparent in this specimen.

10.0 SUMMARY AND RECOMMENDATIONS

10.1 Burial and Site Characteristics

A minimum of 55 discrete individuals were identified from the human skeletal remains recovered from 29 locations along the Missouri River in South Dakota. The human skeletal remains at 20 of these locations were discovered by non-archaeologists, primarily persons utilizing recreation areas along the river. In the majority of these cases the burials had been removed from their in-situ context prior to the arrival of the Corps of Engineers South Dakota field archaeologist. Nine burials were found and recovered by archaeologists under conditions of controlled excavation. The condition of the recovered skeletal remains ranged from good (24%) to very poor (41%). Preservation depended to a great extent upon the length of time the remains were exposed to atmospheric and water weathering. Those remains with the poorest preservation displayed the greatest degree of weathering.

Artifacts were recovered from nine sites. Field notes and the nature of the artifacts suggest that the items at five locations occurred as intentional burial associations, while the recovered artifacts at the remaining four locations are probably only inadvertent inclusions in pit fill. While these artifacts were for the most part undiagnostic, some of them did aid in the identification of culture-historic association. Unmodified faunal elements were recovered from ten locations but beyond basic description, provided minimal information concerning culture-historic association. Eight sites were targeted for radiocarbon dating. Using bone collagen and a single charcoal sample, eleven radiocarbon dates from seven sites were obtained. In three cases multiple samples were dated from the same site. For two sites, these dates were internally consistent, indicating either that contamination was not a factor, or its effects were constant for each sample within the same site. For site 39LM256 three radiocarbon dates were obtained, two from one laboratory and the third from another. The third date was nearly 400 years apart from the other two. While differences in laboratory technique is the most probable cause, multiple interment episodes within the burial context cannot be ruled out. The dates obtained were helpful in identifying the culture-historic position of their respective burials. In only one case was there any inconsistency between previously identified site components and the radiocarbon date.

The sites involved ranged from those with long archaeological and excavation histories, like Red Horse Hawk (39CO34) and Mobridge Village (39WW1), to newly discovered burial locations such as Blue Blanket Point (39WW98). Ten locations were never recorded as sites but were identified only by locale (i.e., Prairie Dog Bay). One location, the LeCompte Catholic Cemetery, was a previously relocated historic cemetery. For the seven sites where culture-historic association could be determined with any certainty, three were placed within the Coalescent tradition, two within the Middle Missouri tradition, and two within the Woodland tradition. In addition, two sites had radiocarbon dates that overlapped two or more culture-historic units (i.e., Woodland-Initial Middle Missouri and Extended Middle Missouri-Extended Coalescent). The remaining 19 sites (excluding the LeCompte Cemetery) lacked either diagnostic artifacts, diagnostic skeletal features, and/or radiocarbon

dates necessary for a precise identification of culture-historic association.

Of the 55 identified individuals, 38 were adult (69%), 18 females, 13 males, and 7 of undetermined sex. Fifteen individuals were classified as juveniles (<16 years of age) and two were of an indeterminate age. Where interment mode was identified, four burials were primary-flexed, four were secondary bundles, and two were pit burials of an undetermined nature. Although interment mode could not be determined for the majority of burials, the underrepresentation of most skeletal elements suggests that secondary interment was common. However, collection and recovery circumstances were probably just as important in establishing which skeletal elements were recovered. The number of individuals recovered from each site ranged from a single individual at sixteen locations (55%) to a single site with seven individuals. Only one individual displayed evidence of dissection or dismemberment prior to interment.

10.2 Dentition

Less than 50% of the potentially recoverable permanent teeth were actually recovered. Despite this data base reduction, the dentitions provided insights into dietary patterns and general health. Occlusal attrition was a factor in dental health, contributing to the eventual loss of teeth in advanced age. Two individuals displayed helicoidal wear, a form of advanced attrition indicative of a less coarse, more processed diet. Interproximal wear was also evident. While higher levels of interproximal wear at earlier ages are characteristic of pre-horticultural societies, small sample sizes made it impossible to interpret the significance of this wear among these individuals. Other features of dental health and hygiene were similar to those seen in other northern Plains populations. Periodontal disease as measured by alveolar resorption ranged from mild to severe. Apical abscessing was frequent, with 11 individuals displaying 29 abscesses. Despite these indicators of poor prophylaxis, calculus deposits were less than expected, even though plaque as a pre-calculus state is a primary contributor to periodontal disease and apical abscessing. While only eight individuals displayed caries, these accounted for a total of 20 lesions. For these individuals this pattern of caries involvement is indicative of a highly processed high carbohydrate diet.

One of the more important dental characteristics observed was enamel hypoplasia. These areas of disrupted enamelogenesis indicate periods of systemic stress, most likely of a nutritional or infectious origin. Although only six individuals displayed enamel hypoplasias, they presented a pattern of mild to moderate stress from one to five years of age in half to whole year intervals. A yearly pattern suggests a seasonal stress possibly related to maize horticulture.

10.3 Anomalies and Pathologies

The composite picture of health and disease created by these varied skeletal samples is similar to that seen in other northern Plains populations. Trauma and arthritis were the two most commonly observed pathologies (38%).

Both forms of arthritis, degenerative joint disease and vertebral osteophytosis were observed. The majority of cases were mild to moderate in severity. Trauma likewise was moderate in level. Eleven of the fifteen cases involved damage to muscle and ligament attachments. These took the form of periosteal reactions and calcified tissue spurs. Only two fractures were observed. Evidence of infection was observed in eight individuals. All cases were attributed to non-specific infections. One juvenile case involved severe systemic infection. Nine individuals displayed what was interpreted as evidence of iron deficiency anemia. A study of Harris' lines was inconclusive.

Anomalous characteristics, developmental and acquired, were nearly as frequent (32%). These included a wide range of features such as lambdoid ossicles, spina bifida occulta, and osseous changes due to multiparity.

10.4 Paleodietary Analysis

The skeletal remains from eight sites were targeted for stable isotope and trace mineral analysis. The results obtained were mixed. Using the $\delta^{13}C$ and $\delta^{15}N$ seven of nine samples indicated a diet consisting primarily of C_4 plants (maize) and terrestrial herbivores (bison). All but one of these sites had a post-horticultural culture-historic association. The remaining two samples, both from site 39LM256, with a radiocarbon dates within the middle to late Woodland, had δ's indicating a diet of terrestrial herbivores with little or no maize consumption.

The analysis of seven trace elements was less clear cut. The sample results were for the most part consistent. Iron concentrations varied widely, possibly due to the type of bone sample used, or perhaps due to iron deficiency. Zinc concentrations also varied, with one individual apparently zinc deficient and two others marginally sufficient. Both iron and zinc deficiency could be the result of a diet with a high maize content. All nine samples were identified as severely copper deficient. The reason for these observations is unknown, but given the nature of these burials (i.e., shoreline erosion) diagenetic factors are the most probable cause.

10.5 Recommendations

Nine of the twenty-nine sites were excavated under controlled conditions by professional archaeologists, yet even in these circumstances it is likely that information was lost due to a lack of records pertaining to the recovery operations in nearly all cases. Greater detail concerning burial mode, placement, context of artifacts, and skeletal characteristics could have enhanced the quality of this analysis. It is recommended that in the future professional archaeologists who salvage human skeletal remains pay greater attention to standard field recording practices such as photography, drawings, and record-keeping in order to enhance the completeness of the potential data base. An example where more detailed excavation records and procedures would have been useful is site 39LM256. Here the commingled remains of seven individuals were recovered. The three radiocarbon dates obtained from these

burials are not in agreement, being separated by more than 400 years. Knowledge of the interment pattern of these remains might have helped in understanding why these dates differ.

It is also recommended that all burials for which there is provenience be recorded as sites. The absence of site numbers makes the organization of these varied skeletal samples cumbersome and inefficient.

While it may be impossible to prevent intentional or unintentional looting of prehistoric graves, it may be possible (even in some cases of severe disturbance) to salvage more information through some form of controlled recovery of disturbed deposits. The postmortem loss of teeth is a case in point. After death, teeth often become loose in their sockets. This makes them prime candidates for postmortem loss. Although teeth make up only a small proportion of the skeleton, the scope of information that they provide in many ways exceeds that of the remainder of the skeleton. Considering how small teeth are, unscreened recovery procedures are inadequate for their consistent collection. Even screening with four-per-inch mesh hardware cloth may not prove sufficient to recover all teeth.

The use of radiocarbon dating to establish the culture-historic position of burials was highly beneficial. It is recommended that this continue on future contracts of this nature. In the absence of diagnostic artifacts and diagnostic human skeletal remains radiocarbon dates are essential.

Two sites in particular were not dated but could have benefitted greatly from radiocarbon analysis. These are Blue Blanket Point (39WW98) (including the burials from Blue Blanket Recreation Area) and the burial at Okobojo Point (Exhibit P, Catalogue No. 17). In the first site, a large number of individuals of apparent pre-Coalescent age were recorded, and at the second site the recovered artifacts, a perforated tooth necklace and perforated radius, are apparently unique for the Middle Missouri subarea. Both sites are recommended for further study, especially radiocarbon analysis. It is also suggested that in the future contractors be permitted the option of requesting additional radiocarbon dating after the initiation of analysis.

The addition of paleodietary analysis was useful yet fell short of the desired goals of this procedure. One difficulty in undertaking this type of analysis is the use of single samples, which may not be indicative of population attributes. While composite pictures are helpful, the study of single burial samples is inadequate, even from the standpoint of creating a permanent data base. Here too, interaction between the Corps of Engineers and future contractors might be desirable in designing a program of more directed analysis. It is also recommended that if paleodietary research is to become a regular feature of this type of skeletal analysis, soil samples be taken from the burial matrix of each bone to be analyzed (see Appendix K). If necessary soil characteristics can then be studied to determine their impact, if any, on the trace element content of human bones under study.

Despite problem areas this research did have substantial value. Although samples were at times incomplete, valuable additions to the data base of varied bioarchaeological characteristics were recorded. Referring back to the

goals of this research (to document the skeletal biology of the peoples represented by these skeletal remains, to place these osteological remains and the sites they represent into the culture-historic framework of the northern Plains, and to demonstrate the value of analyzing miscellaneous human osteological remains), all three have been attained to some degree. It is strongly recommended that this type of research should continue as needed. As the reburial of prehistoric and early historic Amerindian skeletal remains becomes more commonplace, analysis such as this becomes essential in documenting the past.

11.0 GLOSSARY

alveolar - a reference to that portion of the mandible and maxilla containing the tooth sockets

ankylosis - the bony union of a joint, or of two or more separate skeletal elements

appendicular - a reference to that portion of the human skeleton comprising the appendages

apical - in dentistry, a reference to the root tip (i.e., apical abscess)

auricular - a reference to the ear or an ear-shaped bony process (i.e., the auricular area of the innominate bone)

axial - a reference to that portion of the skeleton comprising the vertebral column

bursitis - inflammation of a bursa, or membrane sac surrounding a joint or bony prominence where muscle or tendon movement occurs

cariogenic - promoting the formation of dental caries

cariostatic - retarding the formation of dental caries

cavitation - the formation of a cavity

contralateral - in dentistry, a reference to a homologous tooth on the opposite side of the mandible or maxilla

diploë - the spongy or cancellous bone of the skull

distal - in dentistry, a reference to the surface of a tooth, roughly posterior in orientation, lying on a line terminating at a point farthest away from the midpoint of the jaw

eburnation - polishing of bone due to direct bone to bone contact

enamelogenesis - the process of enamel formation

helicoidal - in dentistry, a reference to a spiral wear pattern of the occlusal surfaces

hyperostosis - an increase or thickening of bone tissue

hypoplasia - any decrease or stoppage of the growth process of an organ (i.e. linear enamel hypoplasia)

hypostotic - a reference to insufficient ossification

infracranial - a reference to that portion of the human skeleton beneath the skull

interproximal - in dentistry, a reference to the area between two adjacent teeth

interstitial - in dentistry, a reference to the contact area between two adjacent teeth (i.e., interstitial wear)

mesial - in dentistry, a reference to the surface of a tooth, roughly anterior in orientation, lying on a line terminating at the midpoint of the jaw

necrosis - a reference to tissue death

occlusal - in dentistry, a reference to the surfaces of the maxillary and mandibular teeth that come into contact during occlusion

osteoma - a bone tumor

osteophytosis - the formation of small bony growths, usually in reference to a form of vertebral arthritis

osteoporosis - a loss of bone mass, resulting in abnormally lightweight bone

periapical - in dentistry, a reference to the area of the alveolar bone circumscribing the root tip

periodontal - a reference to the periodontium, the area of the jaws directly surrounding each tooth

periosteal - a reference to the periosteum, the outer covering of bone

periostitis - an inflammation of the periosteum

popliteal - a reference to the knee, or the area behind the knee

preauricular - a reference to the area of the innominate bone immediately inferior to the auricular area

sclerous - a reference to the formation of new bone tissue in response to inflammation (i.e., osteosclerotic)

spondylolysis - a condition in which the vertebral arch remains unfused to the body

sulcus - a groove

valgus - a reference to an outward turning of a joint, as in the foot or knee

varus - a reference to an inward turning of a joint, as in the foot or knee

12.0 REFERENCES CITED

Abel, A. H.
1932 Chardon's Journal at Fort Clark, 1834-1839. State Historical Society of South Dakota, Pierre.

Anfinson, S.
1982 The prehistoric archaeology of the Prairie Lake Region: A summary from a Minnesota perspective. Journal of the North Dakota Archaeological Association 1:65-90.

Ahler, S. A.
1975a Pattern and Variety in Extended Coalescent Lithic Technology. PhD dissertation, Department of Anthropology, University of Missouri-Columbia. University Microfilms, Ann Arbor.

1975b Extended Coalescent Lithic Technology: Supporting Data. Manuscript on file, Midwest Archeological Center, U. S. National Park Service, Lincoln, Nebraska.

1977a Lithic Resource Utilization Patterns in the Middle Missouri Subarea. Plains Anthropologist, Memoir 13:132-150.

1977b Archeological Reconnaissance and Test Excavation at the Jake White Bull Site, 39CO6, Oahe Reservoir, South Dakota. Department of Anthropology and Archeology, University of North Dakota, Grand Forks. Submitted to the Omaha District, U. S. Army Corps of Engineers.

Ahler, S. A., D. K. Davies, C. R. Falk, and D. B. Madsen
1974 Holocene stratigraphy and archaeology in the middle Missouri River trench, South Dakota. Science 184:905-908.

Ahler, S. A., A. M. Cvancara, D. B. Madsen, and R. W. Kornbrath
1977 Archaeological reconnaissance and test excavation at the Travis 2 site, 39WW15, Oahe Reservoir, South Dakota. Department of Anthropology and Archaeology, University of North Dakota. Report submitted to the Omaha District, U. S. Army Corps of Engineers.

Anderson, J. E.
1968 Skeletal "anomalies" as genetic indicators. In The skeletal biology of earlier human populations, edited by D. R. Brothwell. Pergamon Press, Elmsford.

Audabon, M. R. and E. Coues
1898 Audabon and His Journal, Volume II. John Nimmo, London.

Baerreis, D. A., and J. E. Dallman
n.d. Archeological Investigations Near Mobridge, South Dakota. Manuscript on file, Midwest Archeological Center, U. S. National Park Service, Lincoln, Nebraska.

Bass, W. M.
1964 The variation in the physical types of prehistoric Plains indians. Plains Anthropologist, Memoir 1 9:65-145

1971 Human osteology: a laboratory and field manual of the human skeleton. Missouri Archaeological Society, Columbia.

1976 An early Indian cranium from the Medicine Crow site (39BF2), Buffalo County, South Dakota. American Journal of Physical Anthropology 45:695-700.

1981 Skeletal biology of the United States Plains: a history and personal narrative. Plains Anthropologist, Memoir 17 26:3-18.

1983 The salvage of human skeletal material from the Rygh site, 39-CA-4, Campbell County, South Dakota. In The Anton Rygh excavations and assemblage, Campbell County, South Dakota: A report on materials gathered by Alfred W. Bowers in 1957-1959, with emphasis on the 1958 collection, edited by R. Knudson, J. M. Moe, and A. W. Bowers. University of Idaho Anthropological Research Manuscript Series, No. 75.

Bass, W. M. and H. E. Berryman
1976 Physical Analysis. In Fay Tolton and the Initial Middle Missouri Variant, edited by W. R. Wood. Missouri Archaeological Society Research Series No. 13, Columbia.

Bass, W. M. and W. H. Birkby
1962 The first human skeletal material from the Huff site, 32MO11, and a summary of putative Mandan skeletal material. Plains Anthropologist 7:164-177.

Bass, W.M. and T. W. Phenice
1975 Prehistoric human skeletal material from three sites in North and South Dakota. In The Sonota Complex and associated sites on the Northern Great Plains, edited by R. W. Neuman. Nebraska State Historical Society Publications in Anthropology, No. 6.

Bass, W. M., D. R. Evans, and R. L. Jantz
1971 The Leavenworth Site Cemetery: Archaeology and Physical Anthropology. University of Kansas, Lawrence.

Bender, M. M.
1971 Variations in the $^{13}C/^{12}C$ ratio of plants in relation to the pathway of photosynthetic carbon dioxide. Phytochemistry 10:1239-1244.

Bender, M. M., D. A. Baerreis, and R. L. Steventon
1981 Further light on carbon isotopes and Hopewell agriculture. American Antiquity 46:346-353.

Bennett, K. A.
1972 Lumbo-sacral malformations and spina bifida occulta in a group of proto-historic Modoc Indians. American Journal of Physical Anthropology 36:435-440.

Bergmann, K. E., G. Makosch, and K. H. Tews
1980 Abnormalities of hair zinc concentration in mothers of newborn infants with spina bifida. American Journal of Clinical Nutrition 33:2145-2150.

Berry, R. J.
1979 Section I. Genes and skeletons, ancient and modern. Journal of Human Evolution 8:669-677.

Berry, A. C. and R. J. Berry
1967 Epigenetic Variation in the Human Cranium. Journal of Anatomy 101: 361-379.

Berryman, H. E., D. W. Owsley, and A. M. Henderson
1979 Noncarious interproximal grooves in Arikara Indian dentitions. American Journal of Physical Anthropology 50:209-212.

Bhaskar, S. N.
1981 Synopsis of oral pathology. C. V. Mosby, St. Louis.

Binford, Lewis R.
1978 Nunamiut Ethnoarchaeology. Academic Press, New York.

1980 Willow Smoke and Dogs' Tails: Hunter-gatherer Settlement Systems and Archaeological Site Formation. American Antiquity 45:4-20.

1981 Bones: ancient men and modern myths. Academic Press, New York.

Blakey, M. L. and G. J. Armelagos
1985 Deciduous enamel defects in prehistoric americans from Dickson Mounds: prenatal and postnatal stress. American Journal of Physical Anthropology 66:371-380.

Bock, R.
1979 A handbook of decomposition methods in analytical chemistry. John Wiley and Sons, New York.

Bonnichsen, R.
1973 Some operational aspects of human and animal bone alteration. In Mammalian osteo-archaeology: North America, edited by B. M. Gilbert. Missouri Archaeological Society, Special Publications, Columbia.

Bowers, A. W.
1948 A History of the Mandan and Hidatsa. Unpublished Ph.D. Dissertation, University of Chicago, Chicago.

1963 Investigations in the Mobridge Area, South Dakota. Plains Anthropologist 8:118.

Bradtmiller, B.
1984 Congenital anomalies of the lower spine in two Arikara skeletal series. Plains Anthropologist 29:327-333.

Brätter, P., D. Behne, D. Gawlik, H. Gessner, T. Hofer, U. Rosnick
1980 On the bone trace element content during pregnancy and lactation. In Trace element analytical chemistry in medicine and biology, edited by P. Brätter and P. Schramel. Walter de Gruyter, New York.

Brothwell, D.R.
1981 Digging up bones. 3rd ed. Cornell. Ithaca.

Brothwell, D.R. and A.T. Sandison
1967 Diseases in antiquity. Charles Thomas. Springfield.

Brown, Christopher and C. E. Gustafson
1979 A Key to Postcranial Skeletal Remains of Cattle/Bison, Elk, and Horse. Washington State University, Laboratory of Anthropology, Reports of Investigations 57.

Buikstra, J.E.
1976 Hopewell in the Lower Illinois Valley: a regional study of human biological variability and prehistoric mortuary behavior. Northwestern University Archaeological Program Scientific Papers, No. 2.

Buikstra, J. E. and D. C. Cook
1980 Paleopathology: an american account. Annual Review of Anthropology 9:433-470.

Butler, R. J.
1972 Age-related variability in occlusal wear planes. American Journal of Physical Anthropology 36:381-390.

Byrne, K. B. and D. C. Parris
1987 Reconstruction of the diet of the Middle Woodland Amerindian population at Abbott Farm by bone trace-element analysis. American Journal of Physical Anthropology 74:373-384.

Caldwell, W. W. and R. E. Jensen
1969 The Grand Detour Phase. Smithsonian Institution, River Basin Surveys, Publications in Salvage Archeology 13. Washington, D.C.

Capes, K. H.
1963 The W. B. Nickerson survey and excavations, 1912-1915, of the Southern Manitoba Mounds Region. Anthropological Papers of the National Museum of Canada 4.

Carpenter, J. C.
1976 A comparative study of metric and non-metric traits in a series of modern crania. American Journal of Physical Anthropology 45:337-344.

Carranza, F. A. Jr. (editor)
1984 Glickman's clinical periodontology, sixth edition. W. B. Saunders, Philadelphia.

Church, T.
1985 Test Excavations at Four Sites within the Okobojo Recreation Area, Lake Oahe, Sully County, South Dakota. Archaeological Research Center, Fort Meade, South Dakota, Archeological Investigation Series Number 148.

Clarke, S. K.
1982 The association of early childhood hypoplasias and radiopaque transverse lines in a culturally diverse prehistoric skeletal sample. Human Biology 54:77-84.

Collins, J. Thomas
1974 Amphibians and Reptiles in Kansas. The University of Kansas Museum of Natural History, Lawrence.

Cook, D. C. and J. E. Buikstra
1979 Health and differential survival in prehistoric populations: prenatal dental defects. American Journal of Physical Anthropology 51:649-664.

Comas, J.
1960 Manual of Physical Anthropology. Charles C. Thomas, Springfield.

Cooper, P. l. and R. L. Stephenson
1953 Appraisal of the archaeological resources of the Oahe Reservoir, North and South Dakota. Report for the Missouri Basin Project, Smithsonian Institution.

Corruccini, R.S.
1974 An examination of the meaning of cranial discrete trait for human skeletal biological studies. American Journal of Physical Anthropology 40:425-446.

Corruccini, R.S. and R.L. Ciochon
1976 Morphometric affinities of the human shoulder. American Journal of Physical Anthropology 45:19-38.

Costa, R. L., Jr.
1982 Periodontal disease in the prehistoric Ipiutak and Tigara skeletal remains from Point Hope, Alaska. American Journal of Physical Anthropology 59:97-110.

Coues, E.
1898 Forty Years a Fur Trader on the Upper Missouri: The Personal Narrative of Charles Larpenteur 1833-1872, Volume I. Francis Harper, New York.

Curzon, M. E. J.
1983 Epidemiology of trace elements and dental caries. In Trace elements and dental disease, edited by M. E.j. Curzon and T. W. Cutress. John Wright, Boston.

Curzon, M. E. J. and T. W. Cutress (editors)
1983 Trace elements and dental disease. John Wright, Boston.

Cvancara, Alan M.
1970 Illustrated Key to the Genera and Species of North Dakota Mussels. Contribution from the Institute for Ecological Studies, No. 3. University of North Dakota, Grand Forks.

1983 Aquatic Mollusks of North Dakota. Report of Investigation No. 78. North Dakota Geological Survey, Grand Forks.

Dahlberg, A. A.
1963 Analysis of the American Indian dentition. In Dental Anthropology, edited by D. Brothwell. Pergamon Press, New York.

DeNiro, M. J.
1987 Stable isotopy and archaeology. American Scientist 75:182-191.

DeNiro, M. J. and S. Epstein
1978 Influence of diet on the distribution of carbon isotopes in animals. Geochimica et Cosmochimica Acta 42:495-506.

1981 Influence of diet on the distribution of nitrogen isotopes in animals. Geochimica et Cosmochimica Acta 45:341-351.

DeNiro, M. J. and C. A. Hastorf
1985 Alteration of $^{15}N/^{14}N$ and $^{13}C/^{12}C$ ratios of plant matter during the initial stages of diagenesis: Studies utilizing archaeological specimens from Peru. Geochimica et Cosmochimica Acta 49:97-115.

DeVoto, B. (ed)
1953 The Journals of Lewis and Clark. Houghton Mifflin, Boston.

[illegible], G.
1966 Site file, 32LM104. State Historical Society of North Dakota, Bismarck.

El-Najjar, M. Y.
1976 Maize, malaria, and the anemias the Pre-Columbian New World. Yearbook of Physical Anthropology 20:329-337.

El-Najjar, M. Y. and K. R. McWilliams
1978 Forensic Anthropology. Charles Thomas, Springfield.

El-Najjar, M. Y., M. V. DeSanti, and L. Ozebek
1978 Prevalence and possible etiology of dental enamel hypoplasia. American Journal of Physical Anthropology 48:185-192.

Gregg, J.B., L.J. Zimmerman, J.P. Steele, H. Ferwerda, and P.S. Gregg
1981 Ante-mortem osteopathology at Crow Creek. Plains Anthropologist 25:287-300.

Gregg, M. L.
1985 An Overview of the Prehistory of Western and Central North Dakota. Bureau of Land Management, Cultural Resources Series, No. 1.

Grüneberg, H.
1963 The Pathology of development: a study of inherited skeletal disorders. Wiley, New York.

Haberman, T. W.
1978 Cultural Resources Survey of Areas to be Affected by New Facilities at Two Locations Within the Indian Memorial Recreation Area, Lake Oahe, South Dakota. U. S. Army Corps of Engineers, Omaha.

Haberman, T. W. (editor)
1982 Archaeological Excavations at the Travis I Site, 39CO213, Corson County, South Dakota. South Dakota Archaeological Research Center Contract Investigations Series 37, Fort Meade.

Hambidge, K. M.
1981 Zinc deficiency in man: its origins and effects. In Trace element deficiency: metabolic and physiological consequences, edited by L. Fowden, G. A. Garton, and C. F. Mills. University Press, Cambridge.

Hambidge, K. M., C. E. Casey, and N. F. Krebs
1986 Zinc. In Trace elements in human and animal nutrition, fifth edition, edited by W. Mertz. Academic Press, New York.

Harris, E. D.
1983 Copper in human and animal health. In Trace elements in health, edited by J. Rose. Butterworths, Boston.

Haxo, H. E.
1941 The Journal of La Verendrye, 1738-39. North Dakota History 8: 229-271.

Helal, B.
1986 Foot problems. In Sports injuries and their treatment, edited by B. Helal, J. King, and W. Grange. Chapman and Hall, London.

Helgevold, M. K.
1981 A history of South Dakota Archaeology. Special Publication of the South Dakota Archaeological Society, Number 3, Vermillion.

Henderson, E. M.
1984a Human skeletal remains recovered near Mobridge Village (39WW1)- Oahe Project. In-house Memorandum. U. S. Army Corps of Engineers, Omaha District.

1984b Lake Sharpe Project - recovery of human burial from vicinity of Rousseau Recreation Area. In-house Memorandum. U. S. Army Corps of Engineers, Omaha District.

Herman, F. T.
1972 Historical and Cultural Reconstruction of the Mandan and Arikara Indians as Reported by the Observations of Early American Travellers: 1770-1870. Unpublished M.A. Thesis. Northern State College.

Hershkovitz, I., E. Kobylianski, and B. Arensburg
1982 Coxa vara in a Chalcolithic Population from the Sinai. Current Anthropology 23:320-322.

Hildebolt, C.F., S. Molnar, M. Elvin-Lewis, J.K. McKee
1988 The effect of geochemical factors on prevalences of dental diseases for prehistoric inhabitants of the State of Missouri. American Journal of Physical Anthropology 75:1-14.

Hinton, R.J.
1982 Differences in interproximal wear and occlusal tooth wear among prehistoric Tennessee Indians: implications for masticatory function. American Journal of Physical Anthropology 57:103-115.

Hinton, R.J. and D.S. Carlson
1979 Temporal changes in the human temporomandibular joint size and shape. American Journal of Physical Anthropology 50:325-334.

Houghton, P.
1974 The relationship of the pre-auricular groove of the ilium to pregnancy. American Journal of Physical Anthropology 41:381-389.

Howells, W. W.
1973 Cranial Variation in Man. Papers of the Peabody Museum of Archaeology and Ethnology 67.

Hrdlicka, A.
1939 Practical Anthropometry. Wistar, Philadelphia.

Hughey, D. V.
1980 An overview of Great Plains physical anthropology. In Anthropology on the Great Plains, edited by W. R. Wood and M. Liberty. University of Nebraska Press, Lincoln.

Hurley, L. S.
1979 The role of zinc in prenatal and neonatal development. In Trace metals in health and disease, edited by N. Kharasch. Raven Press, New York.

1981 The roles of trace elements in foetal and neonatal development. In Trace element deficiency: metabolic and physiological consequences, edited by L. Fowden, G. A. Garton, and C. F. Mills. University Press, Cambridge.

Hurt, W. Jr.
1952 Report of the investigation of the Scalp Creek site, 39GR1, and the Ellis Creek site, 39GR2, Gregory County, South Dakota 1941, 1951. South Dakota Archaeological Commission Archaeological Studies Circular 6, Pierre.

Huscher, H. A. and C. H. McNutt
1958 Appraisal of the archaeological resources of the Big Bend Reservoir, South Dakota. Report for the Missouri Basin Project, Smithsonian Institution.

Jantz, R. L.
1972 Cranial variation and microevolution in Arikara skeletal populations. Plains Anthropologist 17:20-35.

1973 Microevolutionary change in Arikara crania: a multivariate analysis. American Journal of Physical Anthropology 38:15-26.

1976 Discriminant Function. In Fay Tolton and the Initial Middle Missouri Variant, edited by W. R. Wood. Missouri Archaeological Society Research Series No. 13, Columbia.

1977a Addendum to Murrill's analysis. In The Talking Crow site: a multicomponent earthlodge village in the Big Bend Region, South Dakota, edited by C. S. Smith. University of Kansas Publications in Anthropology, Number 9, Lawrence.

1977b Craniometric relationships of Plains populations: historical and evolutionary implications. In Trends in Middle Missouri prehistory: a festschrift honoring the contributions of Donald J. Lehmer, edited by W. R. Wood. Plains Anthropologist, Memoir 13 22:162-176.

Jantz, R. L. and D. W. Owsley
1984a Long bone growth variation in the northern and central Plains. American Journal of Physical Anthropology 63:13-20.

1984b Temporal changes in limb proportionality among skeletal samples of Arikara Indians. Annals of Human Biology 11:157-163.

Jantz, R. L. and P. Willey
1983 Temporal and geographic patterning of relative head height in the Central Plains and Middle Missouri areas. Plains Anthropologist 28:59-67.

Jantz, R. L., D. W. Owsley, and P. Willey
1981 Craniometric variation in the northern and central Plains. Plains Anthropologist, Memoir 17 26:19-30.

Jenks, A. E.
1932 The Problem of the Culture From the Arvilla Gravel Pit. American Anthropologist 34:455-466.

Johnson, C.
1984 Time, Space and Cultural Tradition as Factors in Lithic Resource Exploitation in the Middle Missouri Subarea. Plains Anthropologist 29(106):289-302.

Johnson, E.
1973 The Arvilla Complex. Minnesota Prehistoric Archaeology series 9. Minnesota Historical Society, St. Paul.

Johnson, A. E. and W. R. Wood
1980 Prehistoric studies on the Plains. In Anthropology on the Great Plains, edited by W. R. Wood and M. Liberty, pp. 35-51. University of Nebraska Press, Lincoln.

Jurmain, R. D.
1977 Paleoepidemiology of degenerative knee disease. Medical Anthropology 1:1-23.

Kadlecek, D. E.
1984 Human Skeletal Remains Recovered from Blue Blanket Recreation Area - Oahe Project, South Dakota. Memorandum to the Chief, Planning Division. Omaha District, U. S. Army Corps of Engineers.

Kant, J.
1979 Salvage excavations at the Hofer Mound, (39HT2). South Dakota Archaeology 3:91-113.

Kelley, M.A.
1979 Parturition and pelvic changes. American Journal of Physical Anthropology 51:541-554.

Kerley, E. R. and W. M. Bass
1967 Paleopathology: Meeting Ground for Many Disciplines. Science 157:638-644.

Key, M.
1985 Report submitted to Mr. Timothy Nowak, Corps of Engineers South Dakota field archaeologist.

Key, P.
1983 Craniometric relationships among plains Indians: culture-historical and evolutionary implications. University of Tennessee Department of Anthropology Report of Investigations Number 34.

Key, P. and R. L. Jantz
1981 A multivariate analysis of temporal changes in Arikara craniometrics: a methodological approach. American Journal of Physical Anthropology 55:247-259.

Keyes, C. R.
1928 The Hill-Lewis archaeological survey. Minnesota History 9:96-108.

King, J.
1986 Knee injuries. In Sports injuries and their treatment, edited by B. Helal, J. King, and W. Grange. Chapman and Hall, London.

Kivett, M. F.
1952 The Oacoma sites, 39LM26 and 39LM27, Lyman County, South Dakota. A preliminary report on file at the Midwest Archaeological Center, National Park Service, Lincoln.

Klepinger, L. L., J. K. Kuhn, and W. S. Williams
1986 An elemental analysis of archaeological bone from Sicily as a test of predictability of diagenetic change. American Journal of Physical Anthropology 70:325-331.

Knudson, R., J. M. Moe, and A. W. Bowers
1983 The Anton Rygh excavations and assemblage, Campbell County, South Dakota: A report on materials gathered by Alfred W. Bowers in 1957-1959, with an emphasis on the 1958 collection. University of Idaho Anthropological Research Manuscript Series, No. 75.

Kraus, B.S., R.E. Jordan and L. Abrams
1980 Dental anatomy and occlusion. Williams and Wilkins, Baltimore.

Krause, R. A.
1972 The Leavenworth Site: Archaeology of an Historic Arikara Community. University of Kansas, Publications in Anthropology 3. Lawrence.

Kreshover, S. J.
1944 The pathogenesis of enamel hypoplasia: an experimental study. Journal of Dental Research 23:231-238.

Kreshover, S. J. and O. W. Clough
1953 Prenatal influences on tooth development. II. Artificially induced fever in rats. Journal of Dental Research 32:565-577.

Krogman, W. M. and M. Y. Iscan
1986 The human skeleton in forensic medicine. Charles C. Thomas, Springfield.

Kyle, J. H.
1986 Effects of post-burial contamination on the concentrations of major and minor elements in human bones and teeth - the implications for paleodietary research. Journal of Archaeological Science 13:403-416.

Lake, D.
1985 Investigative report. South Dakota Attorney General's Office.

Lallo, J.W. and J.C. Rose
1979 Patterns of stress, disease and mortality in two prehistoric populations from North America. Journal of Human Evolution 8:323-335.

Lallo, J. W., G. J. Armelagos, and R. P. Mensforth
1977 *The role of diet, disease, and physiology in the origin of porotic hyperostosis.* Human Biology 49:471-485.

Lambert, J. B., S. Vlasak Simpson, J. E. Buikstra, and D. Hanson
1983 Electron microprobe analysis of elemental distribution in excavated human femurs. American Journal of Physical Anthropology 62:409-423.

Lambert, J. B. S. M. Vlasek, A. C. Thometz, and J. E. Buikstra
1982 A comparative study of the chemical analysis of ribs and femurs in Woodland populations. American Journal of Physical Anthropology 59:298 -294.

Lass, B.
1981 South Dakota Prehistory. In The future of South Dakota's past, edited by L. J. Zimmerman and L. C. Stewart. Special publication of the South Dakota Archaeological Society Number 2, Vermillion.

Lavelle, C. L.
1972 A comparison between the mandibles of Romano-British and nineteenth century periods. American Journal of Physical Anthropology 36:213-220.

Lees, W. B., M. E. Brown, and R. D. Mandel
1985 Cultural resource reconnaissance along the lower west bank of Lake Francis Case in Gregory and Lyman Counties, South Dakota. Office of Archaeological Research, Museum of Anthropology, University of Kansas, Lawrence. Report submitted to the Omaha District, U. S. Army Corps of Engineers.

Legler, D. W. and L. Menaker
1980 Etiology, epidemiology and clinical implications of caries. In The biologic basis of dental caries, edited by L. Menaker. Harper and Row, Hagerstown.

Lehmer, D. J.
1966 The Fire Heart Creek Site. Smithsonian Institution, River Basin Surveys, Publications in Salvage Archeology 1. Washington, D. C.

1971 Introduction to Middle Missouri Archaeology. U. S. Department of the Interior National Park Service, Anthropological Papers, No. 1.

Lehmer, D. J. and W. W. Caldwell
1966 *Horizon and tradition in the Northern Plains.* American Antiquity 31:511-516.

Lisowski, F.P., G.H. Albrecht, and C.E. Oxnard
1974 The form of the talus in some higher primates. American Journal of Physical Anthropology 41:191-22.

Lovick, S. K.
1980a Appendix C. Lithic Analysis Data. In The Archeology of the White Buffalo Robe Site, Volume II, Appendices, edited by C. H. Lee, pp. 79-267. Department of Anthropology and Archaeology, University of North Dakota. Submitted to Stearns-Roger Engineering Corporation, Denver, Colorado.

1980b Lithic Analysis. In The Archeology of the White Buffalo Robe Site, Volume I, Text, edited by C. H. Lee, pp. 526-617. Department of Anthropology and Archaeology, University of North Dakota. Submitted to Stearns-Roger Engineering Corporation, Denver, Colorado.

Massler, M., I. Schour, and H. G. Poncher
1941 Developmental pattern of the child as reflected in the calcification pattern of the teeth. American Journal of Diseases of Children 62:33-67.

McHenry, H.M.
1975 A new pelvic fragment from Swartkrans and the relationship between the robust and gracile Australopithecines. American Jounral of Physical Anthropology 43:245-262.

1978 Fore and hindlimb proportions in Plio-Pleistocene hominids. American Journal of Physical Anthropology 43:245-262.

McHenry, H.M. and R.S. Corruccini
1975 Distal humerus in hominoid evolution. Folia Primatologica 23:227-234.

1978 The femur in early human evolution. American Journal of Physical Anthropology 49:473-488.

McHenry, H.M., R.S. Corruccini, and F.C. Howell
1976 Analysis of an early hominid ulna from the Omo Basin, Ethiopia. American Journal of Physical Anthropology 44:295-304

McKusick, V.
1978 Mendelian Inheritance in Man, 5th edition. Johns Hopkins, Baltimore.

Mensforth, R. P., C. O. Lovejoy, J. W. Lallo, and G. J. Armelagos
1978 The role of constitutional factors, diet, and infectious disease in the etiology of porotic hyperostosis and periosteal reactions in prehistoric infants and children. Medical Anthropology 2:1-59.

Merchant, V. L. and D. M. Ubelaker
1977 Skeletal growth of the protohistoric Arikara. American Journal of Physical Anthropology 46:61-71.

Meyer, R. W.
1977 The Village Indians of the Upper Missouri. University of Nebraska Press, Lincoln.

Miller, C. F.
1953 The excavation and investigation of Fort Lookout Trading Post II (39LM57) in the Fort Randall Reservoir, South Dakota. Bureau of American Ethnology, Bulletin No. 176., Washington D. C..

Molnar, S.
1971 Human tooth wear, tooth function, and cultural variability. American Journal of Physical Anthropology 34:175-190.

Montgomery, H.
1906 Remains of prehistoric man in the Dakotas. American Anthropologist 8:640-651.

1908 Prehistoric man in Manitoba and Saskatchewan. American Anthropologist 10:33-40.

Mooney, M. M.
1975 George Catlin Letters and Notes on the North American Indians. Clarkson Potter, New York.

Moore, S. M.
1985 Modified Bone and Antler from On-A-Slant Village (32MO26). Journal of the North Dakota Archaeological Association 2:37-66.

Moorrees, C. F. A., E. A. Fanning, and E. E. Hunt, Jr.
1963 Age variation of formation stages for ten permanent teeth. Journal of Dental Research 42:1490-1502.

Morhart, R. and R. Fitzgerald
1980 Microbial aspects of dental caries. In The biologic basis of dental caries, edited by L. Menaker. Harper and Row, Hagerstown.

Morse, D.
1978 Ancient disease in the Midwest. Illinois State Museum Reports of Investigation No.15.

Murphy, T.
1959a The changing patterns of dentin exposure in human tooth attrition. American Journal of Physical Anthropology 17:167-178.

1959b Gradients of dentine exposure in human molar teeth attrition. American Journal of Physical Anthropology 17:179-186.

1964 Reduction of the dental arch by approximal attrition: a quantitative assessment. British Dental Journal 116:483-488.

Murray, P. F.
1972 Bone, Antler, and Shell Artifacts. In The Schultz Site at Green Point, edited by James E. Fitting, pp. 225-243. Memoirs of the Museum of Anthropology, University of Michigan, No.4. Ann Arbor.

Murrill, R. I.
1977 Human skeletal remains. In The Talking Crow site: a multicomponent earthlodge village in the Big Bend Region, South Dakota, edited by C. S. Smith. University of Kansas Publications in Anthropology, Number 9, Lawrence.

Neuman, R. W.
1960 The Truman Mound site, Big Bend Reservoir, South Dakota. American Antiquity 26:78-92.

1975 The Sonota Complex and Associated Sites on the Northern Great Plains. Nebraska State Historical Society, Publications in Anthropology 6. Lincoln, Nebraska.

Nisonson, B., E. Hershman, W. N. Scott, and J. Yost
1984 The knee. In Principles of Sports Medicine, edited by W. N. Scott, B. Nisonson, and J. A. Nicholas. Williams and Wilkins, Baltimore.

Nowak, T. R.
1985a Oahe Project - Prehistoric Human Skeletons Recovered from Mobridge Vicinity. In-house Memorandum. U. S. Army Corps of Engineers, Omaha District.

1985b Lake Francis Case - inspection of four (4) multi-component archaeological sites impacted by erosion. In-house Memorandum. U. S. Army Corps of Engineers, Omaha District.

1986 Oahe Project - human bones from LeCompte Catholic Cemetery. In-house Memorandum. U. S. Army Corps of Engineers, Omaha District.

Obey, W. A.
1974 The Arvilla people. The Minnesota Archaeologist 33:1-33.

Olsen, S. J.
1960 Post-Cranial Skeletal Characteristics of Bison and Bos. Papers of the Peabody Museum of Archaeology and Ethnology 35(4). Harvard University, Cambridge.

1964 Mammal Remains from Archaeological Sites, Part I - Southeastern and Southwestern United States. Papers of the Peabody Museum of Archaeology and Ethnology, 56(1). Harvard University, Cambridge.

1979 Osteology for the Archaeologist. Papers of the Peabody Museum of Archaeology and Ethnology, 56 (3,4,5). Harvard University, Cambridge.

Orban, B. J.
1957 Oral histology and embryology. Mosby, St. Louis.

Ortner, D. J. and W. G. Putschar
1981 Identification of pathological conditions in human skeletal remains. Smithsonian Contributions to Anthropology, Number 28, Washington, D.C..

Osmond, C. B., W. G. Allaway, B. G. Sutton, J. H. Troughton. O. Queiroz, U. Lüttge, and K. Winter
1973 Carbon isotope discrimination in photosynthesis of CAM plants. Nature 246:41-42.

Ossenberg, N. S.
1970 The Influence of Artificial Cranial Deformation on Discontinuous Morphological Traits. American Journal of Physical Anthropology 33:356-371.

1974a Origins and Relationships of Woodland Peoples: The Evidence of Cranial Morphology. In Aspects of Upper Great Lakes Anthropology: Papers in Honor of Lloyd Wilford. Minnesota Prehistoric Archaeology Series No. 11, St. Paul.

1974b The mylohyoid bridge: an anomalous derivative of Meckel's cartilage. Journal of Dental Research 53:77-82.

1976 Within and Between Race Distances in Population Studies Based on Discrete Traits of the Human Skull. American Journal of Physical Anthropology 45:701-716.

Ostrom, C. A.
1980 Clinical cariology. In The biologic basis of dental caries, edited 1. Menaker. Harper and Row, Hagerstown.

Owsley, D. W.
1981 Mobridge site cemeteries: controversy concerning the location of the Over and Stirling burials. Plains Anthropologist, Memoir 17 26:43-48.

Owsley, D. W. and W. M. Bass
1979 A demographic analysis of skeletons from the Larson site (39WW2), Walworth County, South Dakota: vital statistics. American Journal of Physical Anthropology 51:145-154.

Owsley, D. W. and R. L. Jantz
1978 Intracemetery morphological variation in Arikara crania from the Sully site (39SL4), Sully County, South Dakota. Plains Anthropologist 23:139-147.

Owsley, D.W. and S.A. Symes
1981 Morphological differences between Mandan and historic Arikara crania. Plains Anthropologist, Memoir 17 26:49-56.

Owsley, D. W., H. E. Berryman, and W. M. Bass
1977 Demographic and osteological evidence for warfare at the Larson site, South Dakota. Plains Anthropologist 22:119-131.

Owsley, D. W., G. D. Slutzky, M. F. Guagliardo, and L. M. Deitrick
1981 Interpopulation relationships of four Post-Contact Coalescent sites from South Dakota: Four Bear (39DW2), Oahe Village (39HU2), Stony Point Village (39ST235), and Swan Creek (39WW7). Plains Anthropologist, Memoir 17, 26:31-42.

Palkovich, A.
1981 Demography and disease patterns in a protohistoric Plains group: A study of the Mobridge site (39WW1). Plains Anthropologist, Memoir 17 26: 71-84.

Parker, R. B. and H. Toots
1980 Trace elements in bones as paleobiological indicators. In, Fossils in the Making, edited by A. K. Behrensmeyer and A. P. Hill. Chicago University Press, Chicago.

Patterson, D.K.
1984 A diachronic study of dental paleopathology and attritional status of prehistoric Ontario pre-Iroquois and Iroquois populations. National Museum of Man Mercury Series, Archaeological Survey of Canada Paper No. 122.

Peterson, L. and P. Renström
1986 Sports injuries: their prevention and treatment. Yearbook Medical Publishers, Chicago.

Pindborg, J. J.
1970 Pathology of the dental hard tissues. Saunders, Philadelphia.

Post, R. H.
1966 Pilot study: population differences in the frequency of spina bifida occulta. Eugenics Quarterly 13:341-352.

Prasad, A. S.
1978 Trace elements and iron in human metabolism. Plenum, New York.

Praschma, M. and R. Sundick
1980 Recommendations for age and sex diagnoses of skeletons. Journal of Human Evolution 9:517-549.

Price, T. D., M. J. Schoeninger, and G. J. Armelagos
1985 Bone chemistry and past behavior: an overview. Journal of Human Evolution 14:419-447.

Putschar, W. G. J.
1976 The structure of the human symphysis pubis with special consideration of parturition and its sequelae. American Journal of Physical Anthropology 45:589-599.

Rightmire, G. P.
1970 Iron age skulls from southern Africa re-assessed by multiple discriminant analysis. American Journal of Physical Anthropology 33:147-168.

Rose, J. C.
1977 Defective enamel histology of prehistoric teeth from Illinois. American Journal of Physical Anthropology 46:439-446.

Rose, J. C., G. J. Armelagos, and J. W. Lallo
1978 Histological enamel indicator of childhood stress in prehistoric skeletal samples. American Journal of Physical Anthropology 49:511-532.

Rose, J. C., M. Kay, B. A. Burnett, and E. B. Riddick Jr.
1983 Analysis of human osteological remains, multi-county areas, North Dakota. Department of Anthropology, University of Arkansas. Report Submitted to the Omaha District Office of the U.S. Army Corps of Engineers.

Rose, J. C., M. K. Marks, and M. Kay
1984 Analysis of human osteological remains from multi-county areas, South Dakota. Department of Anthropology, University of Arkansas. Report submitted to the Omaha District Office of the U. S. Army Corps of Engineers.

Sarnat, B. G. and I. S. Schour
1941 Enamel hypoplasia (chronologic enamel aplasia) in relation to systemic disease: a chronologic, morphologic, and etiologic classification. Journal of the American Dental Association 28:1989-2000.

1942 Enamel hypoplasia (chronologic enamel aplasia) in relation to systemic disease: a chronologic, morphologic, and etiologic classification. Journal of the American Dental Association 29:67-75.

Saul, F. P.
1976 Osteobiography: Life History Recorded in Bone. In: The Measures of Man, edited by E. Giles and J. Friedlaender. Peabody Museum, New York.

Saunders, S.R.
1978 The development and distribution of discontinuous morphological variation of the human infracranial skeleton. National Museum of Man Mercury Series. Archaeological Survey of Canada Paper No. 18.

Schneider, F. S.
1972 An analysis of waste flakes from sites in the Upper Knife-Heart Region, North Dakota. Plains Anthropologist 17:91-100.

1975 The results of archaeological investigations at the Moe site, 32MN101, North Dakota. Report from the University of North dakota to the National Park Service.

1982 A model of prehistoric cultural developments in the James River Valley of North Dakota. Journal of the North Dakota Archaeological Association 1:113-133.

Schneider, K. N.
1986 Dental caries, enamel composition, and subsistence among prehistoric Amerindians of Ohio. American Journal of Physical Anthropology 71:95-102.

Schoeninger, M. J. and M. J. DeNiro
1984 Nitrogen and carbon isotopic composition of bone collagen from marine and terrestrial animals. Geochimica et Cosmochimica Acta 48:625-639.

Schoeninger, M. J., M. J. DeNiro, and H. Tauber
1983 $^{15}N/^{14}N$ ratios of bone collagen reflect marine and terrestrial components of prehistoric human diet. Science 220:1381-1383.

Sciulli, P.W.
1977 A descriptive and comparative study of the deciduous dentition of prehistoric Ohio Valley Amerindians. American Journal of Physical Anthropology 47:71-80.

1979 Size and morphology of the permanent dentition of Ohio Valley Amerindians. American Journal of Physical Anthropology 50:615-628.

Shafer, W. G., M. K. Hine, and B. M. Levy
1983 A textbook of oral pathology, fourth edition. W. B. Saunders, Philadelphia.

Sigstad, J. S. and J. K. Sigstad (editors)
1973 Archaeological Field Notes of W. H. Over. South Dakota State Archaeologist, Research Bulletin No. 1.

Sillen, A. and M. Kavanaugh
1982 Strontium and paleodietary research: A review. Yearbook of Physical Anthropology 25:67-90.

Smith, C. S.
1977 The Talking Crow site: a multicomponent earthlodge village in the Big Bend Region, South Dakota. University of Kansas Publications in Anthropology, Number 9, Lawrence.

Smith, B.H.
1984 Patterns of molar wear in hunter-gatherers and agriculturalists. American Journal of Physical Anthropology 63:39-56.

Snortland-Coles, J. S.
n.d. Excavations at the Jamestown Mounds. State Historical Society of North Dakota. Report in preparation.

Snyder-Winder, S.
1981 Infracranial non-metric variation: an assessment of its value for biological distance analysis. Ph.D. dissertation, Indiana University, Bloomington.

Soltan, M. H. and D. M. Jenkins
1982 Maternal and fetal plasma zinc concentration and fetal abnormality. British Journal of Obstetrics and Gynaecology 89: 56-58.

Sperry, J. E.
1968 The Shermer Site 32EM10. Plains Anthropologist, Memoir 5.

Steele, J. P., J. B. Gregg, and A. M. Holzhueter
1965 Paleopathology in the Dakotas. South Dakota Journal of Medicine 18: 17-29.

Steinacher, T. L.
1981 Archaeological survey and investigations of selected federal lands on the west bank of the Lake Sharpe/Big Bend project area. Division of Archaeological Research, Department of Anthropology, University of Nebraska. Report submitted to the Omaha District, U. S. Army Corps of Engineers.

Steinacher, T. L. and D. L. Toom
1983 Archaeological investigations at the Rousseau site (39HU102): 1978-1979. In Archaeological investigations within federal lands located on the east bank of the Lake Sharpe project area, South Dakota: 1978-1979 final report, edited C. R. Falk. Technical Report No. 83-04, Division of Archaeological Research, Department of Anthropology, University of Nebraska.

Steinbock, R.T.
1976 Paleopathological diagnosis and interpretation. Charles Thomas, Springfield.

Stewart, T.D.
1979 Essentials of forensic anthropology. Charles Thomas, Springfield.

Stuart-Macadam, P.
1985 Porotic hyperostosis: Representative of a childhood condition. American Journal of Physical Anthropology 66:391-398.

1987 Porotic hyperostosis: new evidence to support the anemia theory. American Journal of Physical Anthropology 74:521-526.

Stuiver, M. and G. W. Pearson
1986 High-precision calibration of the radiocarbon time scale, AD 1950-500 BC. Radiocarbon 28:805-838.

Suchey, J. M., D. V. Wisely, D. F. Green, and T. T. Noguchi
1979 Analysis of dorsal pitting in the Os pubis in an extensive sample of modern American females. American Journal of Physical Anthropology 51: 517-523.

Susman, R.A.
1979 Comparative and functional morphology of hominoid fingers. American Journal of Physical Anthropology 50:215-236.

Sweeney, E. A., J. Cabrera, J. Urritia, and L. Mata
1969 Factors associated with linear hypoplasia of human deciduous incisors. Journal of Dental Research 48:1275-1279.

Syms, L.
1982 The Arvilla burial complex: a re-assessment. Journal of the North Dakota Archaeological Association 1:135-166.

Thwaites, R. G.
1906 Early Western Travels, 1748-1846, Vol. 24. Arthur Clark, Cleveland.

Tibesar, W. L., P. H. Sanders, M. L. McFaul, and K. H. Dueholm
1986 Evaluative testing of selected sites long the left bank of Lake Francis Case, South Dakota. Larson-Tibesar Associates. Report submitted to the Omaha District, U. S. Army Corps of Engineers.

Toom, D. L. and J. A. Artz
1985 An archaeological survey of selected federal lands on the west bank of Lake Oahe, Oahe Dam vicinity Stanley County, South Dakota, 1984. Department of Anthropology and Archaeology, University of North Dakota. Report submitted to the Omaha District, U. S. Army Corps of Engineers.

Toom, D. L. and P. R. Picha
1984 An archaeological survey of selected federal lands on the west bank of the Big Bend/Lake Sharpe Project Area, Lyman and Stanley Counties, Dakota 1983. Department of Anthropology and Archaeology, University of North Dakota, Contribution Number 198. Report submitted to the Omaha District, U. S. Army Corps of Engineers.

Toom, D. L., T. L. Steinacher, and C. R. Falk
1979 Archaeological investigations of selected sites located along the west shore of the Big Bend-Lake Sharpe project area, South Dakota: 1978-1979. Technical Report No. 79-10, Department of Anthropology, University of Nebraska, Lincoln.

Trimble, M. K.
1979 An ethnohistorical interpretation of the spread of smallpox in the northern Plains utilizing concepts of disease ecology. Department of Anthropology, University of Missouri-Columbia. Submitted to the National Park Service, Midwest Archaeological Center, Lincoln.

Trotter, M. and G.C. Glesser
1958 A re-evaluation of stature based on measurements taken during life and on long bones after death. American Journal of Physical Anthropology 16:79-123.

Turner, C. G. II, and J. D. Cadien
1969 Dental chipping in Aleuts, Eskimos and Indians. American Journal of Physical Anthropology 31:303-310.

Ubelaker, D.H.
1978 Human skeletal remains: excavation, analysis and interpretation. Aldine, Chicago.

Ubelaker, D.H., T.W. Phenice, and W.M. Bass
1969 Artificial interproximal grooving of the teeth in American Indians. American Journal of Physical Anthropology 30:151-152.

Ullrich, H.
1975 Estimation of fertility by means of pregnancy and childbirth alterations at the pubis, ilium, and the sacrum. Ossa 2:23-39.

Underwood, E. J.
1977 Trace elements in human and animal nutrition, fourth edition. Academic press, New York.

1981 The incidence of trace element deficiency diseases. In Trace element deficiency: metabolic and physiological consequences, edited by L. Fowden, G. A. Garton, and C. F. Mills. University Press, Cambridge.

Utermohle, C. J. and S. L. Zegura
1982 Intra- and interobserver error in craniometry: a cautionary tale. American Journal of Physical Anthropology 57:303-310.

Utley, R. M.
1984 The Indian Frontier of the American West 1846 - 1890. University of New Mexico, Albuquerque.

van der Merwe. N. J.
1982 Carbon isotopes, photosynthesis, and archaeology. American Scientist 70:596-606.

van der Merwe, A. Curtenius Roosevelt, and J. C. Vogel
1981 Isotopic evidence for prehistoric subsistence change at Parmana, Venezuela. Nature 292:536-538.

Vogel, J. C., and N. J. van der Merwe
1977 Isotopic evidence for early maize cultivation in New York state. American Antiquity 42:238-242.

Wallace, J.A.
1974 Approximal grooving of teeth. American Journal of Physical Anthropology 40:385-390.

Walravens, P. A.
1984 Acrodermatitis Enteropathica: pathogenesis and implications for treatment. In Metabolism of trace metals in man, Volume II, edited by O. M. Rennert and W-Y Chan. CRC Press, Boca Raton.

Weaver, D.S.
1979 Application of the likelihood ratio test to age estimation using the infant and child temporal bone. American Journal of Physical Anthropology 50:263-269.

Webb, W. S. and D. L. DeJarnette
1942 An Archeological Survey of the Pickwick Basin in the Adjacent Portions of the States of Alabama, Mississippi and Tennessee. Smithsonian Institution, Bureau of American Ethnology Bulletin 129. Washington, D.C.

Wedel, W. R.
1955 Archaeological Materials From the Vicinity of Mobridge, South Dakota. Bureau of American Ethnology, Bulletin 157:69-188.

1961 Prehistoric Man on the Great Plains. University of Oklahoma Press, Norman.

Wells, C.
1967 A new approach to paleopathology: Harris's lines. In Disease in Antiquity, edited by D. R. Brothwell and A. T. Sandison. Charles Thomas, Springfield.

Weltfish, G.
1965 The Lost Universe: Pawnee Life and Culture. University of Nebraska Press, Lincoln.

Weston, T., D. A. Goulding, and S. A. Ahler
1979 Archaeological monitoring and shoreline reconnaissance at the Travis 2 site, 39WW15, Oahe Reservoir, South Dakota. Department of Anthropology and Archaeology, University of North Dakota. Report submitted to the Omaha District, U. S. Army Corps of Engineers.

Wheat, J. B.
1979 The Jurgens Site. Plains Anthropologist, Memoir 15.

Wheeler, R.C.
1974 Dental anatomy, physiology and occlusion. Saunders, Philadelphia.

White, G. E.
1975 Dental caries. Charles C. Thomas, Springfield.

Will, G. F.
1910 Some New Missouri River Valley Sites in North Dakota. American Anthropologist 12: 58-60.

1924 Archaeology of the Upper Missouri Valley. American Museum of Natural History, Anthropological Papers, Vol. 22.

1933 A Resume of North Dakota Archaeology. North Dakota Historical Quarterly 7: 150-161.

Will, G. F. and T. C. Hecker
1944 The Upper Missouri River valley aboriginal culture in North Dakota. North Dakota Historical Quarterly 11:5-126.

Will, G. F. and H. J. Spinden
1906 The Mandans. A study of their culture, archaeology, and language. Peabody Museum of American Archaeology and Ethnology, Volume 3. Harvard University, Cambridge.

Willey, P.
1982 Osteology of the Crow Creek Massacre. Ph. D. dissertation, University of Tennessee, Knoxville.

Willey, P., R. W. Mann, P. H. Moore-Jansen, R. L. Jantz, M. Guilbeau, and L. Meadows
1987 Human skeletal material from the South Dakota Archaeological Research Center. Department of Anthropology, University of Tennessee, Knoxville, Tennessee. Report submitted to the State of South Dakota and the South Dakota Archaeological Research Center.

Williams, J.A.
1982a The Inkster burial. 32GF19: skeletal biology of a Northeastern Plains Woodland population. Journal of the North Dakota Archaeological Association 1:181-215.

1982b An enlarged paracondylar process and associated anomalies in a Plains Woodland burial. Plains Anthropologist 27:323-326.

1985a Volume II: Skeletal Biology. In The Jamestown Mounds Project. The State Historical Society of North Dakota, Bismarck.

1985b Evidence of hydatid disease in a Plains Woodland burial. Plains Anthropologist 30:25-28.

1985c Site 32RY100: Skeletal biology of the infracranial skeleton and related parameters. Contract report submitted to the State Historical Society of North Dakota, Bismarck.

1987 Possible nutritional stress in a Plains Woodland skeletal population. Proceedings of the North Dakota Academy of Science 41:61.

n.d. Description of human skeletal remains from the Arvilla site (32GF1) and the De Spiegler site (39RO23). Manuscript on file, Department of Anthropology, University of North Dakota.

Williams J. A. and J .S. Snortland-Coles
1986 Pre-Contact Tuberculosis in a Plains Woodland Mortuary. Plains Anthropologist 31: 249-252.

Wilson, G. L.
1917 Agriculture of the Hidatsa Indians: An Indian interpretation. University of Minnesota Studies in the Social Sciences, No. 2, St. Paul.

Winham, R. P.
1983 Report on the Salvaging of Three Burials Exposed along the West Bank of Lake Francis Case, North of Chamberlain, South Dakota. Archeology Laboratory of the Center for Western Studies, Augustana College, Sioux Falls, South Dakota. Submitted to the Omaha District, U. S. Army Corps of Engineers.

Winham, R. P. and E. J. Lueck
1984 Report of a Cultural Resource Reconnaissance of Selected Areas Along the White River and Along the West Bank of Lake Francis Case. Archeology Laboratory of the Center for Western Studies, Augustana College, Sioux Falls, South Dakota. Submitted to the Omaha District, U. S. Army Corps of Engineers.

1987 Cultural resource reconnaissance along portions of Lake Oahe in Stanley and Dewey Counties, South Dakota. Center for Western Studies, Augustana College, Archaeological Contract Series Number 25. Report submitted to the Omaha District, U.S. Army Corps of Engineers.

Wolpoff, M. H.
1971 Interstitial wear. American Journal of Physical Anthropology 34:201-228.

Wood, W. R.
1967 An Interpretation of Mandan Culture History. Smithsonian Institution, Bureau of American Ethnology Bulletin 198. Washington, D.C.

Wood, W. R. (editor)
1976 Fay Tolton and the Initial Middle Missouri Variant. Missouri Archaeological Society Research Series No. 13, Columbia.

Wood, W. R. and T. D. Thiessen
1985 Early Fur Trade on the Northern Plains: Canadian Traders Among the Mandan and Hidatsa Indians, 1738 - 1818. University of Oklahoma Press, Norman.

Wood, W. R. and A. R. Woolworth
1964 The Paul Brave Site (32SI4), Oahe Reservoir Area, North Dakota. Smithsonian Institution, River Basin Surveys Papers, No. 33, Bureau of American Ethnology Bulletin 189:1-66. Washington, D.C.

Zimmerman, L. J.
1985 Peoples of Prehistoric South Dakota. University of Nebraska Press, Lincoln.

Zimmerman, L. J. and T. E. Emerson
1979 Archaeological reconnaissance and evaluation. In A cultural resources of the federal lands on the east bank of Lake Francis Case, South Dakota, edited by G. D. Olson and L. J. Zimmerman. Augustana Research Institute, Augustana College and the Archaeology Laboratory, University of South Dakota. Report submitted to the Omaha District, U. S. Army Corps of Engineers.

Zimmerman, L. J., T. Emerson, P. Willey, M. Swegle, J. B. Gregg, P. Gregg, E. White, C. White, T. Haberman, and M. P. Bumstead
1981 The Crow Creek site (39BF11) massacre: a preliminary report. University of South Dakota Archaeology Laboratory. Report submitted to the Omaha District, U. S. Army Corps of Engineers.

Zimmerman, M.R. and M.A. Kelley
1982 Atlas of human paleopathology. Praeger. New York.

Zoebeck, T.S.
1983 Postcraniometric variation among the Arikara. Ph. D. dissertation, University of Tennessee, Knoxville.

APPENDIX A

Scope-of-Work

SCOPE OF WORK
ANALYSIS OF HUMAN
OSTEOLOGICAL REMAINS FOR
MULTI-COUNTY AREAS, SOUTH DAKOTA

I. INTRODUCTION

1. The United States, by and acting through the U.S. Army Corps of Engineers, Omaha District, is soliciting study outlines for analysis of human and animal osteological remains and artifacts retrieved as a result of cultural resource investigations conducted in different counties of South Dakota along the Missouri River.

2. There are a minimum of 50 individuals available for analysis. These individuals are represented by one or more portions of fragmentary and complete skeletons. These collections have not been adequately described, analyzed, and placed in appropriate temporal and cultural perspective. The analysis will serve to make detailed information about these collections available to the professional archeological community and the public in general.

II. SCOPE

The work to be accomplished shall include: (1) a comprehensive search of existing literature and records pertaining to the archeology and history of the lands and sites associated with the individual and multiple burials where possible, (2) analysis of human and animal osteological remains and associated artifacts, (3) compilation of all data into a detailed project report, and (4) a journal article on any aspect of the research.

III. COLLECTIONS AVAILABLE FOR ANALYSIS

The materials available for analysis are listed below in Exhibits A through BB. This inventory identifies most, but not all of the osteological and other material to be analyzed. The exhibits are attached to the scope.

All skeletal material, available field and lab notes, and associated artifacts will be shipped to the contractor. The contractor will return them by an economical means upon completion of the analysis to an agreed to storage facility. The information we have available regarding the skeletal remains are to be found in the partial bibliography included with the exhibits. Exhibits without references have no information available that may be found in any reports.

IV. METHODOLOGY

A. Literature and Records Search. This shall include but not be limited to the following sources: published and unpublished site records, manuscripts, theses, dissertations, reports, journals, and books. Sources that should be contacted are the National Park Service (Midwest Archeological Center) in Lincoln, Nebraska, the Pierre Real Estate Office of the Omaha District, the University of South Dakota, the South Dakota State Historical Society, South Dakota Archaeological Research Center at Fort Meade, other local historical societies, professional and amateur archeologists, or individuals knowledgeable about the collections, local history, and other osteological studies for this region.

B. Analysis of Data. Analysis shall consider all site materials. If possible, the data analysis shall produce age, sex, minimum number present, pathological conditions, trauma, nonmetric traits, and measurement data on the human remains, including indices and cultural affiliations. If necessary, all artifacts shall be carefully cleaned, catalogued, recorded, and stored in containers. This analysis must be accurate and extensive enough to allow future researchers information from which to easily utilize in future studies. Comprehensive documentation of the skeletal material will be made in black and white and color photographs and slides. The more complete skeletal series shall have x-rays of the skulls, tibias, anomalies, and pathologies if condition of the material permits. Any x-ray or

photographic documentation of the material will display a metric scale. Further, the measurements taken from the osteological material will be metric; using appropriate anthropometric instruments and devices.

In addition, specialized analysis shall be performed upon the following material:

Site	Number	Exhibit
Red Horse Hawk (39CO34)	1	A
Anton Rygh (39CA4)	2A & 2B	B
Howes (39HU203)	8	H
39LM59	20	S
39LM57	20	T
Scalp Creek Cemetery (39GR321)	21	U
39LM256	22	V
Stony Point (39ST235)	23	W

Analysis of these specimens must include radiocarbon dating and may include any or all of the following analytical techniques: trace element, carbon and nitrogen stable isotope, and any others. The exact application of these analyses and their relevancy to current research topics in the Plains must be explicitly delineated in the study outline.

V. REPORT OF FINDINGS.

The Contractor shall prepare two reports. The first report shall be a technical report detailing the study rationale, the methodology, the results, and recommendations for additional work. The technical report shall include, but shall not be limited to the following sections: (1) abstract, (2) introduction, (3) results of background research, (4) methodology, (5) discussion and evaluation of project results, (6) summary, (7) references, and (8) appendices as necessary.

1. Abstract. The abstract shall be a synopsis of the report stating the conclusions and recommendations. It will not exceed 150 words.

2. Introduction. The introduction shall include, but not necessarily be limited to, a statement of purpose, delineation of the research goals, and a general statement of the nature of the study.

3. Background Research. Results of the background research should minimally develop a research orientation, illuminate problem areas, and indicate possible ways for obtaining answers to questions raised during the research phase.

4. Methodology. The methodology section shall be of sufficient detail to describe the data available, recording, classification, analysis procedures, and chronological determination techniques.

5. Results. Discussion and evaluation of the results must be presented in a logical and understandable manner.

6. Summary. The summary will be concise and definitive.

7. References. All references cited will be listed in the standard American Antiquity style.

8. Appendices. The appendix shall consist of a copy of the laboratory records, an inventory and description of all skeletal material and associated artifacts, including tabulation of observable measurements and indices.

Information presented in the report shall be in textual, tabular, and graphic forms, whichever are more appropriate, effective, and advantageous to communicate necessary information. The contractor shall give every consideration to the use of nontextual forms of presentation, particularly photographs and tables, to maximize the quantity and quality of information per

page. The contractor is also required to complete DD Form 1473, Report Documentation Page.

The contractor shall submit a suitable article for submission to Plains Anthropologist, American Antiquity or other professional journal. This article shall include the following information: name of sponsor, contract number, and brief description of the nature of the contract. The draft of the article shall be submitted at the same time as the draft copy of the report. The purpose of the article is to insure a wider dissemination of the information derived from the study. The article may focus on any facet of the research, but shall include the above information.

VI. DISPOSITION OF ORIGINAL RECORDS AND ARTIFACTS

A. All original records, and photographic and x-ray documentation are property of the U.S. Army Corps of Engineers, Omaha District, and will be relinquished to the Corps of Engineers, Omaha District, at the completion of the project. All artifacts, faunal material, or other material shall be processed, catalogued, and stored in containers plainly marked "Property of the U.S. Government, Corps of Engineers, Omaha District," and deposited at a public facility mutually agreed to by the contractor and the Government. This will be the state in which the material was recovered. The archeological data and records must be maintained in a facility accessible to future researchers. Retrieval of these materials by the U.S. Army Corps of Engineers for their future use is reserved.

B. Neither the contractor nor his representatives will release or publish any sketch, photograph, report, or other material of any nature, obtained or prepared while this contract is in effect, without specific written approval from the Technical Officer.

VII. WORK SCHEDULE

The contractor is expected to pursue the study in a professional manner to meet the target dates set out below.

A. Eight (8) copies of the completed reports, in draft form, shall be submitted to the Omaha District Office. The draft will be edited for major spelling and grammatical errors prior to submittal for review and comment or it will be returned for corrections.

B. Copies of the draft technical report and the draft journal article will be submitted 150 calendar days after the contractor is notified to proceed. The Government shall have a maximum of 45 calendar days to review and comment. The contractor shall have 45 calendar days to include the review comments into the final report and final journal article and submit the final original report with all negatives, photographs, slides, x-rays, charts, tables, and standard drawings to the Government. The text shall be "camera ready."

C. The Government will reproduce the final technical report and the final journal article for distribution to appropriate State and Federal agencies per ER 1105-2-50 and interested parties. The contractor will receive 25 copies for personal use.

VIII. CONTRACTOR QUALIFICATIONS

A. The minimum professional qualifications for the Principal Investigator and key consultants are those given in 36 CFR Part 61.5, "Professional Qualifications." The contractor shall utilize interdisciplinary skills and knowledge as necessary to fulfill the requirements of this contract.

B. In the event of controversy or court challenge of the report or journal article, the Principal Investigator responsible for the validity the information in the documents shall testify on behalf of the Government's support of the report findings.

IX. INSTITUTIONAL OR CORPORATION QUALIFICATION

The contractor must provide, or demonstrate access to the following capabilities:

A. Adequate permanent laboratory equipment necessary to conduct operations defined in the scope of the work. However, this qualification may be waived under circumstances of extreme need through negotiation.

B. Adequate laboratory and office space and facilities for proper treatment, analysis, and storage of specimens and records likely to be obtained from the project. This does not necessarily include such specialized facilities as pollen, geochemical, or radiological laboratories, but does include facilities sufficient to properly preserve or stabilize specimens for any subsequent specialized analysis.

X. METHOD OF PAYMENT

Payment for services rendered will be made upon receipt by the Government of the draft report and journal article, for 50 percent of the contract price. The remaining 50 percent will be paid upon final acceptance of the contract documents by the Government.

XI. EVALUATION FACTORS FOR AWARD

A. The offeror shall submit with their study outline a detailed statement of the method proposed for accomplishing the work, as well as the number

and type of personnel proposed. This statement will become a part of any contract awarded and will be adhered to during performance unless changed by mutual agreement after award of the contract.

B. The offeror shall submit with their study outline, a work sequence diagram that clearly illustrates the sequences of events that will be followed in the expected implementation of the project goals in the form of the flow chart. The information provided in the chart sheet includes a realistic schedule.

C. The offeror shall also submit with the study outline a breakdown of costs in sufficient detail to allow evaluation of the cost of each area of the work.

D. An evaluation of each study outline will be made to determine if the methods proposed for accomplishing the work and personnel to be employed are considered adequate and in conformance with the purchase order specifications. In order to be considered in the evaluation, qualification information, including vitae on key personnel to be assigned to the project, must be submitted with the proposal.

E. The following technical factors listed in descending order of importance shall be evaluated and rated.

1. Personnel
    a. Professional Qualifications
    b. Knowledge of the Study Area
    c. Sufficient Number

2. Methodology
    a. Procedure for Literature Investigation
    b. Analysis Procedure
    c. Research Design
    d. Work and Expenditure Schedules

3. Institution or Company

a. Work Completed in a timely manner

b. Facilities

c. Prior Experience

F. Price will also be considered as a significant factor in the evaluation.

EXHIBITS A-BB
OSTEOLOGICAL AND ARTIFACT MATERIALS

EXHIBIT A

Corson County, South Dakota

#1 Red Horse Hawk 39C034 (Adult)

1 skull
1 mandible
24 vertebrae and fragments
31 ribs and fragments
1 sternum
2 clavicles
2 scapulas
2 humeri
2 radii
2 ulnas
1 pelvis
2 femurs
2 patellas
2 tibias
2 fibula
61 phalanges, hand and foot bones
22 misc. bone fragments

Artifacts

7 undecorated body sherds
1 bone ornament
1 bone tool
2 flakes
4 misc. lithic pieces

Animal Bone

4 bison? long bone ends
2 clam shells
11 animal bone fragments

References:

Haberman, Thomas W. ed.

1978 Cultural Resouces Survey of areas to be affected by new facilities at two locations within the Indian Memorial Recreation Area, Lake Oahe, South Dakota. Report prepared for U.S. Army Corps of Engineers, Omaha District. Purchase Order No. DACW45-78-M2745.

1982 Archaeological Excavations at the Travis I Site, 39C0213, Corson County, South Dakota. Contract Investigations, Series 37. South Dakota Archaeological Research Center, Fort Meade. This report (pp 28-29) lists additional references to Red Horse Hawk.

Nowak, Timothy R.

1985 "Oahe Project-Prehistoric Human Skeletons recovered from Mobridge Vicinity." In-house memorandum. U.S. Army Engineers District, Omaha.

EXHIBIT B

Campbell County, South Dakota

#2A Anton Rygh Site, 39CA4 (Adult)

16 vertebrae
18 ribs and fragments
1 clavical
2 scapula fragments
2 humeri
2 radii
2 tibias
1 right inominate
2 phalanges
Misc. bone fragments including animal

#2B Anton Rygh Site, 39CA4 (Adult, Child, Infant)

Adult	Animal
3 vertebrae fragments	1 bone tool
3 rib fragments	1 misc. bone fragment
1 clavicle	Child
1 scapula	1 scapula fragment
1 humerus	Infant
1 ulna	1 partial mandible
1 pelvis	1 partial skull
2 femurs	
2 tibias	
1 patella	
2 foot bone fragments	

References:

Falk, Carl R.; Pepperl, Robert E.; Bozell, John R.; McCormick, Mary E.; and Snyder, Lynn M.
A Cultural Resource Survey of the East Shore of Lake Oahe, South Dakota. Department of Anthropology, Division of Archeological Research, University of Nebraska, Lincoln. Technical Report 83-01. Submitted to the U.S. Army Corps of Engineers. Contract No. DACW45-78-C-0159. DRAFT REPORT.

Knudson, Ruthann; Moe, Jeanne M.; and Bowers, Alfred W.
1983 The Anton Rygh Excavations and Assemblage, Campbell County, South Dakota: A report on materials gathered by Alfred W. Bowers in 1957- 1959, with emphasis on the 1958 collection. University of Idaho Anthropological Research Manuscript Series, No. 75.

Nowak, Timothy R.
1985 "Oahe Project - Prehistoric Human Skeletons Recovered from Mobridge Vicinity." In-house memorandum, U.S. Army Engineers District, Omaha.

EXHIBIT C

Sully County, South Dakota

#3 Sully Site, 39SL4 (Adults)
2 skulls
1 mandible

Note: The material was turned in by collectors; no additional data is available.

Reference: See Falk et. al. manuscript above.

EXHIBIT D

Walworth County, South Dakota

#4 Blue Blanket Recreation Area (Adult), located near Site 39WW47

1 skull	1 inominate
3 vertebrae	2 femurs
12 ribs	2 tibias
1 clavicle	2 fibulas
2 humeri	Animal Bone
2 ulnas	11 misc. bone fragments

Legal Description: SW¼, SW¼, NE¼, SE¼, Section 2, Township 123 North, Range 79 West.

EXHIBIT E

Walworth County, South Dakota

#5 Blue Blanket Recreation Area (Adult), located near Site 39WW45

1 skull	1 pelvis
1 mandible	2 femurs and fragments
1 vertebra	2 fragmentary tibias
8 ribs and fragments	20 phalanges, hand and foot bones
1 humerus	28 misc. burned and unburned bone fragments
1 radius	
1 ulna	

Reference: See Falk et. al. manuscript above.

EXHIBIT F

#6 (Child), located near Site 39BF235

1 skull	1 scapula
1 mandible fragment	1 humerus
2 vertebrae	2 phalanges
2 ribs	

Reference: None

EXHIBIT G

Walworth County, South Dakota

#7 Mobridge Village 39WW1 (Adult, Child)

1 fragmentary child's skull	1 pelvis
11 vertebrae	1 fragmentary child's sacrum?
32 ribs and fragments	1 femur
1 clavicle	2 tibias
2 scapulas	2 fibulas
2 humeri	18 phalanges and feet bones
1 radius	Animal Bone
1 ulna	8 misc. bone and teeth

Reference:

Rose, Jerome C.; Marks, Murray K.; Kay, Marvin; and Riddick, Earl B.
1984 Analysis of Human Osteological Remains from Multi-County Areas, South Dakota. Radiology Associates and Department of Anthropology, University of Arkansas, Fayetteville. Submitted to U.S. Army Corps of Engineers, Omaha District. Contract Number DACW45-83-M-2506. This report lists additional references for 38WW1 (pp 132-146).

EXHIBIT H

Hughes County, South Dakota

#8 Howes Site 39HU203 (Adult)

1 fragmentary skull	1 ulna
2 fragmentary mandibles	1 fragmentary pelvis
25 vertebrae and fragments	1 femur fragments
31 ribs and fragments	2 tibial fragments
2 clavicles	1 fibula fragment
2 scapulas and fragments	5 phalanges
1 humerus	29 misc. bone fragments
1 radius	

Reference:

Falk, C. R. (editor)
1984 Archeological Investigations Within Federal Lands Located on the East Bank of the Lake Sharpe Project Area, South Dakota: 1978-1979 Final Report Eight volumes. Division of Archeological Research, Department of Anthropology, University of Nebraska. Technical Report 83-04. Submitted to the U.S. Army Corps of Engineers, Omaha District. Contract Number DACW45-78-C-1036.

EXHIBIT I

Walworth County, South Dakota

#9, 10 Blue Blanket Recreation Area (Adults, Adolescents, Children?), located near site 39WW98

3 skulls	2 patellas
2 mandibles	6 tibias
52 vertebrae and fragments	5 fibulas
+100 ribs and fragments	13 phalanges
1 sternum body	4 foot bones?
6 scapulas	26 misc. and immature long bones
6 humeri	Artifacts
4 ulnas	1 bone bead
5 inominates	Animal Remains
1 ?sacrum	clam shell
4 femurs	misc. animal bone

Reference: See Falk et. al. manuscript above.

EXHIBIT J

Walworth County, South Dakota

#11 Blue Blanket Recreation Area (Child), located near Site 39WW98

1 skull	1 scapula
2 mandible fragments	2 humerus fragments
19 vertebrae and fragments	1 femur epiphysis
37 ribs and fragments	4 phalanges
1 clavicle	3 long bone fragments

Note: Located near site 39WW98

Reference: See Falk et. al. manuscript above.

EXHIBIT K

#12 Pike Haven Recreation Area (Adult?)
1 skull

Legal Description: NE¼, NW¼, NE¼, SE¼, Section 4, Township 14 North, Range 81 West.

Reference: See Falk et. al. manuscript above.

EXHIBIT L

Lyman County, South Dakota

#13 Oacoma (Adult?)
1 fragmentary skull

Reference:

Peters, Winham R.; and Lueck, Edward J.
1984 Report of a Cultural Resources Reconnaissance of Selected Areas Along the White River and Along the West Bank of Lake Francis Case. Two volumns - Archeology Laboratory of the Center for Western Studies, Augustana College, Sioux Falls. Archeological Contract Series Number 11. Submitted to the U.S. Army Corps of Engineers, Omaha District. Contract Number DACW45-83-C-0184.

EXHIBIT M

Stanley County, South Dakota

#14 Brush Creek Area (Adult)

1 skull	2 ulnas
1 mandible	1 inominate
3 vertebrae and fragments	2 femurs
20 ribs and fragments	2 patellas
1 clavicle	2 tibias
2 scapula fragments	2 fibulas
2 humeri	16 phalanges
2 radii	Misc. Bone Fragments

Note: Reported by John Hoffman, manager of Pike Haven Resort. Collected by Matt Bilodeau, Oahe Park Manager,

Legal Description: SW¼, SW¼, SW¼, SE¼, Section 4, Township 9 North, Range 28 East, Stanley County, South Dakota.

Reference: See Falk et. al. manuscript above.

EXHIBIT N

#15 Elm Creek Recreation Area (Adults, Child)

Adults	Child
1 humerus	1 radius
2 femurs	2 tibia
3 tibias	1 fibula
1 fibula	2 misc. bone fragments
4 anima long bone fragments	

Collected by Corps Rangers. Provenience unknown but probably associated with 39BR22.

Reference:

Olson, Gary D.; Zimmerman, Larry J.; Emerson, Thomas E.
1979 A Cultural Resources Reconnaissance of the Federal Lands on the East Bank of Lake Francis Case, South Dakota. Two volumes. Augustana Research Institute, Augustana College, Sioux Falls and The Archeology Laboratory, University of South Dakota, Vermillion. Submitted to the U.S. Army Corps of Engineers, Omaha District. Contract Number DACW45-78-C-0018.

EXHIBIT O

#16 Blue Blanket Recreation Area, locatd near Site 39WW98

1 skull	22 phalanges
1 fragmentary mandible	Misc. bone fragments
vertebrae fragments	1 jar of wood pieces
rib fragments	1 washer? or ring?
long bone fragments	vial with beads

References: See Falk et. al. manuscript above.

Exhibit P

Sully County, South Dakota

#17 Okobojo Point (Children)

- 1 fragmentary skull
- 1 fragmentary mandible
- 42 vertebrae fragments
- 41 ribs and fragments
- 1 scapula
- 2 humeri
- 2 radii
- 2 ulnas
- 4 pelvic fragments
- 1 fragmented femur
- 11 phalanges and foot bones
- 13 misc. long bone fragments
- +50 misc. bone fragments

Artifacts

- 2 long bones with small holes at each end. Bone beads?
- 56 beads made from teeth
- 1 animal long bone with two circular holes of human manufacture

Animal

- 10 small long bones

Reference:

Church, Tim
1985 Test excavations at four sites within the Okobojo Recreation Area, Lake Oahe, Sully County, South Dakota, July 1985. *Archeological Research Center Contract Investigation, Series Number 148.*

Also, see Falk et. al. manuscript above.

EXHIBIT Q

#18 LeCompte Cemetery (Adult)

- 1 inominate
- 1 pubis/ischial fragment
- 1 phalange (removed for C13/C14 sample)

Reference: We are currently examining the Corps cemetery relocation files.

EXHIBIT R

Charles Mix County, South Dakota

#19 Prairie Dog Bay (Adult?)

- 2 femurs
- 2 tibias

Note: The remains were found by Jim Hill of Dante, South Dakota. They were found approximately 1 week prior to Easter (about 4 April 1983). They were turned over to Corps' Park Ranger, Ray Proffit on 2 December 1983. Hill stated he was fishing along the shoreline when he noticed the bones.

Legal Description: NW¼, NE¼, SW¼, NW¼, Section 5, Township 95 North, Range 65 West.

Reference: None

EXHIBIT S

Lyman County, South Dakota

#20 FC22, Site 39LM59

1 body sherd in bag
1 body sherd from burial fill in bag
Soil/charcoal sample from around lower burial fill

Bag 1 of 1 upper burial
1 foot bone
1 clavicle
1 unifacial lithic tool- Bijou Hills quartziet

Burial exposed behind front burial - lower rear burial
1 L inominate
1 manubrium
5 vertebrae and fragments
2 rib fragments
1 plain body sherd

Lower front burial
L/R inominates
4 ribs and fragment
1 ulna
4 vertebrae and fragments

Front lower burial (but may include some lower rear burial also)
1 sacrum in 2 pieces
1 sternal body
13 vertebrae and fragments
22 phalanges, hand and foot bones
15 rib fragments
+100 misc. bone fragments

Lower burial front (may include lower rear burial also
1 radius
1 clavical
3 scapula fragments
3 phalanges
10 vertebral fragments
30 rib fragments
29 misc. bone fragments

Bone from slump & misc. bones from front lower burial but may not include some from rear lower burial
17 phalanges and foot? bones
1 vertebral fragment
5 rib fragments
1 scapula fragment
3 inominate fragments
21 misc. bone fragments

References:

Win..., R. Peter
1983 Report on the salvaging of three burials exposed along the west bank of Lake Francis Case, north of Chamberlin, South Dakota. Augustana College Archeological Contract, Series No. 8.

Also, see Winham and Lueck 1984 report above.

EXHIBIT T

Lyman County, South Dakota

#20 FC23, 39LM57

1 R femur
2 mandibles (fragments)
1 vertibral fragment
1 skull fragment
8 misc. bones
1 animal skull fragment

References:

Miller, Carl F.
1960 The Excavation and Investigation of Fort Lookout Trading Post II (39LM57) in the Fort Randall Reservoir, South Dakota River Basin Surveys Papers, No. 17. Bureau of American Ethnology Bulletin 176, Washington.

See Winham 1983 report above.

See Winham and Lueck 1984 report above.

EXHIBIT U

#21 39GR321, Scalp Creek Cemetery

Box 1
Test Pit No. 1
Burial No. 2
Bag No. 4 (L) parietal
Bag No. 5 (R) parietal
Bag No. 6 (l) parietal, 4 pieces
Bag No. 7 (R) parietal, 2 pieces
Bag No. 8 frontal fragments
Bag No. 9 (R) temporal
Bag No. 10 frontal fragments
Bag No. 11 2 (R) parietal frags
Bag No. 12 frontal fragment
Bag No. 13 misc. bone fragments
Bag No. 14 ulna
Bag No. 15 loose skull fragments
Bag No. 16 misc. facial bones

Box 2
Test Pit No. 2
Burials Nos. 1 and 2
Test Pit No. 2 at 60 cm - 1 bone fragment
Bone from pit fill - section that broke off prior to ensitu excavation 69 cm-84 cm B.S. - misc. bone fragments
Burial Pit "A/B" 80 cm BS - femur fragment
Burial Pit "A" - misc bone fragments
Bone from burial pit "C" - 1 rib fragment
Burial No. 1 - removed from int bank - misc. bone fragments
Bone in 6 vials - misc. fragments
Misc. bone test Pit No. 2
Misc. bone from lake shore and slump deposits

? skull frag which fell off cut bank
? (L) occipatel
? loose fragments removed during profiling
? (R) parietal, 1 occipital, 1 symphsial bone
? occipital, (L) parietal, (R) parietal
? 1 bag with 2 vials misc. bone fragments
? bones from shore below burial 2

References:

See Winham 1983 report above.

See Winham and Lueck 1984 report above.

EXHIBIT V

#22 FC21, 39LM256

Boxed Bones (Audlt)

7 femurs
2 tibias
1 fibula
2 humeri
3 radii
1 ulna
(L)/(R) inominates
2 scapulas
2/3 of mandible
2 misc. bone fragments
1 bone rib tool

Small bag (Child)
2 rib fragments
1 tooth - immature
2 misc. bone fragments

General and from slumping (Child, Infant, Adult)
1 humerus fragment - A
1 fibula fragment - A
(L) mandible fragment - A/C?
3 ulnas - C/I-fragments
(L) ilium - I
1 radius fragment - A
2 vertebra fragments - A?
1 femur fragment - I
9 ribs and fragments A-C-I
7 skull fragments - C
1 phalange fragment
5 misc. animal bones
40 misc. bone fragments
1 fragmentary skull
2 snail shells
1 small rodent long bone
1 mandible fragment

Bag 1 Skull B - (Top left) Adult
1 fragmentary skull
1 projectile point
1 snail shell
50 misc. bone fragments

Skull F - Adult
1 fragmentary skull
1 mandible
1 vertebral fragment
1 small rodent femur?

Bag 3 Skull D - Child
2 skull fragments

Bag 2 Skull C
1 fragmentary skull
1 vertebral fragment

Skull G - Adult
4 rib fragments
5 vertebral fragments

Skull A
1 mostly complete skull

Skull E

References:

See Winham 1983 report above.

See Winham and Lueck 1984 report above.

EXHIBIT W

Stanley County, South Dakota

#23 Stony Point Site 39ST235 (Adult)

1 fragmentary maxilla
1 fragmentary mandible
20 vertebrae and fragments
19 ribs and fragments
2 clavicles
1 scapula
2 humeri
2 radii
2 ulnas
1 partial pelvis
2 femurs
2 tibias
2 fibulas
13 phalanges and foot bones
+50 misc. bone fragments

Reference: See Falk (ed.) 1984 report above.

EXHIBIT X

#25 Swanson Village 39 (Adult), 39BR16 or 39BR13

3 skull fragments
2 ribs
1 scapula
1 humerus
1 radius
2 inominates
1 femur
2 tibias
1 misc. animal fragment

Legal Description: SW¼, NW¼, SE¼, SE¼, Section 15, Township 105 North, Range 71 West.

Note: Collected from beach by Park Ranger.

Reference: See Olson, Zimmerman, and Emerson 1979 report above.

#26 Skulls (2) of unknown provience turned into the archeology laboratory at South Dakota State University, Brookings, South Dakota. Presumed to have been collected somewhere along the Missouri River.

EXHIBIT Y

Charles Mix County, South Dakota

#27 39CH210 (Adults?)

1 fragmentary skull
1 fragmentary mandible
7 fragmentary vertebrae
2 rib fragments
1 clavicle fragment
1 scapula fragment
3 humerus fragments
1 ulna fragment
2 fragmentary femurs
1 patella
2 tibial fragments
16 phalanges, hand, foot bone fragments
+100 misc. bone fragments

References:

Tibesar, William L.; Sanders, Paul H.; McFaul, Michael L.; and Dueholm, Keith H.
n.d. Evaluation Testing of Selected Sites along the Left Bank of Lake Francis Case, South Dakota. Larson-Tibesar Associates, Laramie. Submitted to the U.S. Army Corps of Engineers, Omaha District. Contract Number DACW45-83-C-0240. DRAFT REPORT.

See Olson, Zimmerman, and Emerson 1979 report above.

EXHIBIT Z

Walworth County, South Dakota

#28 North of Walth Bay (Adult)
1 skull in 2 pieces

References: None

EXHIBIT AA

#29 Platte Creek Recreation Area (Adult)
1 skull

Note: Turned over to Park Rangers on 20 May 1985 by Dennis Shadsen of Platte, South Dakota.

Legal Description: NW¼, SW¼, NE¼, NE¼, Section 21, Township 98 North, Range 9 West.

Reference: None

EXHIBIT BB

Brule County, South Dakota

#30 39BR10 (Adult)
3 skull fragments 1 fibula fragment

Note: Collected from beach by Park Rangers.

References: See Olson, Zimmerman, and Emerson 1979 report above.

APPENDIX B

Site/Exhibit Inventories[1]

[1]unless otherwise identified, items listed are human osteological remains

DACW4587M0274

Red Horse Hawk (39C034)

exhibit A - catalogue #1

item #	description
a-1	r. humerus
a-2	r. femur
a-3	r. tibia
a-4	cranium
a-5	mandible
a-6	#8 miscellaneous teeth, permanent
a-7	damaged l. femur
a-8	l. humerus
a-9	l. tibia
a-10	l. radius
a-11	r. radius
a-12	l. ulna
a-13	fragmentary r. ulna
a-14	l. fibula
a-15	damaged r. fibula
a-16	damaged l. scapula
a-17	damaged r. scapula
a-18	fragmentary l. innominate
a-19	damaged r. innominate
a-20	#5 innominate fragments
a-21	sacrum
a-22	coccyx
a-23	damaged sternum (body)
a-24	damaged cervical vertebra
a-25	atlas
a-26	thoracic vertebra
a-27	axis
a-28	sternum (manubrium)
a-29	thoracic vertebra
a-30	thoracic vertebra
a-31	damaged thoracic vertebra
a-32	cervical vertebra
a-33	cervical vertebra
a-34	thoracic vertebra
a-35	thoracic vertebra
a-36	damaged lumbar vertebra
a-37	damaged thoracic vertebra
a-38	cervical vertebra
a-39	cervical vertebra
a-40	thoracic vertebra

DACW4587M0274

Red Horse Hawk (39C034)

exhibit A - catalogue #1

item #	description
a-41	thoracic vertebra
a-42	damaged lumbar vertebra, L5
a-43	damaged thoracic vertebra
a-44	thoracic vertebra
a-45	lumbar vertebra
a-46	lumbar vertebra fragment
a-47	lumbar vertebra fragment
a-48	l. patella
a-49	r. patella
a-50	l. clavicle
a-51	r. clavicle
a-52	r. rib
a-53	l. rib
a-54	l. rib
a-55	l. rib
a-56	l. rib
a-57	r. rib
a-58	r. rib
a-59	l. rib fragment
a-60	l. rib
a-61	l. rib
a-62	l. rib
a-63	l. rib
a-64	l. rib
a-65	r. rib
a-66	r. rib fragment
a-67	r. rib fragment
a-68	r. rib fragment
a-69	r. rib fragment
a-70	r. rib fragment
a-71	r. rib fragment
a-72	r. rib fragment
a-73	r. rib fragment
a-74	r. rib fragment
a-75	r. rib fragment
a-76	l. rib
a-77	r. rib fragment
a-78	r. rib fragment
a-79	r. rib fragment
a-80	#5 rib fragments
a-81	hyoid
a-82	l. talus

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Red Horse Hawk (39CO34)

exhibit A - catalogue #1

item #	description
a-83	r. calcaneus
a-84	l. calcaneus
a-85	r. talus
a-86	l. #1 metatarsal
a-87	l. navicular
a-88	r. cuboid
a-89	l. cuboid
a-90	l. #1 cuneiform
a-91	r. #1 cuneiform
a-92	l. #3 metatarsal
a-93	r. #5 metatarsal
a-94	damaged r. #1 metatarsal
a-95	r. #3 cuneiform
a-96	r. #4 metatarsal
a-97	l. #2 metatarsal
a-98	l. #4 metatarsal
a-99	#6 tarsal phalanges
a-100	#14 carpal phalanges
a-101	ossified tissue
a-102	r. lesser multangular
a-103	r. lunate
a-104	#3 sesamoid bones
a-105	metatarsal fragment
a-106	r. #2 metacarpal
a-107	r. #3 metacarpal
a-108	l. #1 metacarpal
a-109	r. #1 metacarpal
a-110	l. #2 metacarpal
a-111	r. #5 metacarpal
a-112	l. #3 metacarpal
a-113	r. #1 metacarpal
a-114	l. greater multangular
a-115	r. navicular
a-116	r. capitate
a-117	l. lesser multangular
a-118	r. greater multangular
a-119	l. triquetral
a-120	r. triquetral
a-121	r. hamate
a-122	#24 miscellaneous bone fragments
a-123	#2 limonite concretion
a-124	#3 unmodified flaking debris

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Red Horse Hawk (39CO34)

exhibit A - catalogue #1

item #	description
a-125	utilized flake
a-126	#7 body sherds
a-127	pointed rib tool
a-128	polished bone disk
a-129	#11 unidentified mammalian faunal elements
a-130	Ictalaurus spine
a-131	Lampsilis, r. valve
a-132	Ligumia, l. valve
a-133	Bison, distal l. femur
a-134	Bison, proximal l. femur
a-135	Bison, distal l. humerus
a-136	Bison, distal l. radius/ulna

DACW4587M0274

Anton Rygh (39CA4)

exhibit B - catalogue #2A

item #	description
b-1	damaged l. ulna
b-2	damaged l. tibia
b-3	damaged r. tibia
b-4	r. humerus
b-5	r. radius
b-6	fragmentary l. humerus
b-7	damaged l. radius
b-8	r. ulna
b-9	r. clavicle
b-10	fragmentary r. scapula
b-11	l. #1 metacarpal
b-12	proximal tarsal phalanx
b-13	l. scapula fragment
b-14	fragmentary l. temporal
b-15	#5 miscellaneous bone fragments
b-16	fragmentary r. innominate
b-17	r. rib
b-18	r. rib
b-19	r. rib
b-20	r. rib
b-21	l. rib fragment
b-22	r. rib
b-23	r. rib fragment
b-24	damaged r. rib
b-25	fragmentary l. rib
b-26	rib fragment
b-27	rib fragment
b-28	fragmentary r.rib
b-29	r. rib
b-30	r. rib
b-31	fragmentary r. rib
b-32	fragmentary l. rib
b-33	r. rib fragment
b-34	fragmentary r. innominate
b-35	lumbar vertebra
b-36	thoracic vertebra
b-37	thoracic vertebra
b-38	thoracic vertebra, T12
b-39	thoracic vertebra
b-40	axis
b-41	thoracic vertebra

DACW4587M0274

Anton Rygh (39CA4)

exhibit B - catalogue #2A

item #	description
b-42	thoracic vertebra
b-43	lumbar vertebra
b-44	thoracic vertebra
b-45	thoracic vertebra
b-46	thoracic vertebra
b-47	thoracic vertebra
b-48	thoracic vertebra
b-49	thoracic vertebra, T11
b-50	lumbar vertebra

DACW4587M0274

Anton Rygh (39CA4)

exhibit B - catalogue #2B

item #	description
b-51	fragmentary l. humerus
b-52	r. femur
b-53	damaged l. radius
b-54	l. femur
b-55	r. tibia
b-56	l. tibia
b-57	r. patella
b-58	l. scapula
b-59	damaged l. clavicle
b-60	r. rib fragment
b-61	l. calcaneus
b-62	r. calcaneus
b-63	l. talus
b-64	fragmentary l. calcaneus
b-65	r. talus
b-66	r. cuboid
b-67	r. navicular
b-68	r. #4 metatarsal
b-69	r. #2 metatarsal
b-70	#3 r. innominate fragments
b-71	#29 miscellaneous bone fragments
b-72	#3 l. scapula fragments, subadult
b-73	r. mandible half, infant
b-74	l. temporal, infant
b-75	r. squamous occipital, infant
b-76	limonite concretion
b-77	worked scapula fragment, faunal
b-78	<u>Bison</u>, scapula fragment

DACW4587M0274

Sully (39SL4)

exhibit C - catalogue #3

item #	description
c-1	damaged adult male cranium
c-2	adult skull w/damaged mandible
c-3	#10 miscellaneous permanent teeth

DACW4587M0274

Blue Blanket Recreation Area

exhibit D - catalogue #4

item #	description
d-1	cranium
d-2	l. innominate
d-3	l. femur
d-4	damaged l. tibia
d-5	r. tibia
d-6	damaged r. clavicle
d-7	r. fibula
d-8	l. ulna
d-9	r. humerus
d-10	l. humerus
d-11	l. fibula
d-12	r. radius
d-13	l. radius
d-14	r. ulna
d-15	r. femur
d-16	damaged lumbar vertebra
d-17	damaged lumbar vertebra
d-18	damaged thoracic vertebra
d-19	l. rib
d-20	l. rib fragment
d-21	r. rib fragment
d-22	l. rib
d-23	r. rib
d-24	r. rib
d-25	l. rib
d-26	damaged r. rib
d-27	l. rib
d-28	r. rib
d-29	damaged r. rib
d-30	r. rib
d-31	*Bison*, l. metacarpal fragment
d-32	*Bison*, l. metacarpal fragment
d-33	mammalian rib fragment
d-34	unidentified mammalian bone fragment
d-35	unidentified mammalian bone fragment
d-36	unidentified mammalian bone fragment
d-37	unidentified mammalian bone fragment
d-38	unidentified mammalian bone fragment

DACW4587M0274

Blue Blanket Recreation Area

exhibit D - catalogue #4

item #	description
d-39	unidentified mammalian bone fragment
d-40	unidentified mammalian bone fragment
d-41	unidentified mammalian bone fragment
d-42	unidentified mammalian bone fragment

DACW4587M0274

Blue Blanket Recreation Area

exhibit E - catalogue #5

item #	description
e-1	male skull
e-2	#7 miscellaneous permanent teeth
e-3	r. innominate
e-4	l. innominate
e-5	sacrum
e-6	lumbar vertebra
e-7	lumbar vertebra
e-8	lumbar vertebra
e-9	lumbar vertebra
e-10	ossified thyroid cartilage
e-11	l. rib
e-12	fragmentary l. rib
e-13	l. rib
e-14	l. rib
e-15	l. rib
e-16	l. rib
e-17	l. rib
e-18	hyoid
e-19	l. femur
e-20	l. radius
e-21	l. humerus
e-22	l. ulna
e-23	l. tibia fragment
e-24	r. tibia fragment
e-25	r. tibia fragment
e-26	l. tibia fragment
e-27	r. femur fragment
e-28	r. femur fragment
e-29	#54 miscellaneous charred bone fragments
e-30	l. #1 cuneiform
e-31	r. #3 cuneiform
e-32	r. #5 metatarsal
e-33	r. #2 metatarsal
e-34	r. #1 metatarsal
e-35	r. #3 metatarsal
e-36	r. #3 metacarpal
e-37	r. #2 metacarpal
e-38	proximal carpal phalanx
e-39	l. #1 metacarpal
e-40	l. #3 metacarpal
e-41	l. #2 metacarpal

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Blue Blanket Recreation Area

exhibit E - catalogue #5

item #	description
e-42	r. #4 metacarpal
e-43	l. #4 metacarpal
e-44	l. #5 metacarpal
e-45	r. #5 metacarpal
e-46	proximal carpal phalanx
e-47	proximal carpal phalanx
e-48	distal carpal phalanx
e-49	r. #4 metatarsal

DACW4587M0274

exhibit F - catalogue #6

item #	description
f-1	cranium, juvenile
f-2	damaged mandible, juvenile
f-3	#2 miscellaneous teeth, permanent
f-4	r. humerus, juvenile
f-5	l. scapula, juvenile
f-6	r. metacarpal, juvenile
f-7	l. rib, juvenile
f-8	r. metacarpal, juvenile
f-9	damaged cervical vertebra, juvenile
f-10	cervical vertebra, juvenile
f-11	l. rib, juvenile

DACW4587M0274

Mobridge (39WW1)

exhibit G - catalogue #7

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item #	description
g-1	fragmentary skull, juvenile
g-2	l. femur
g-3	l. tibia
g-4	l. humerus
g-5	r. tibia
g-6	r. humerus
g-7	r. radius
g-8	r. ulna
g-9	r. fibula
g-10	damaged l. fibula
g-11	l. scapula
g-12	damaged r. scapula
g-13	damaged r. innominate
g-14	l. innominate
g-15	sacrum
g-16	fragmentary r. rib
g-17	r. rib
g-18	fragmentary r. rib
g-19	r. rib
g-20	r. rib
g-21	r. rib
g-22	r. rib fragment
g-23	r. rib fragment
g-24	r. rib fragment
g-25	r. rib fragment
g-26	r. rib fragment
g-27	r. rib fragment
g-28	r. rib fragment
g-29	r. rib fragment
g-30	l. rib fragment
g-31	fragmentary l. rib
g-32	fragmentary l. rib
g-33	fragmentary l. rib
g-34	l. rib fragment
g-35	l. rib fragment
g-36	l. rib fragment
g-37	l. rib fragment
g-38	8 rib fragments
g-39	damaged thoracic vertebra
g-40	thoracic vertebra
g-41	thoracic vertebra

DACW4587M0274

Mobridge (39WW1)

exhibit G - catalogue #7

item #	description
g-42	thoracic vertebra
g-43	thoracic vertebra
g-44	thoracic vertebra
g-45	thoracic vertebra, T12
g-46	lumbar vertebra
g-47	lumbar vertebra
g-48	lumbar vertebra
g-49	lumbar vertebra
g-50	damaged l. clavicle
g-51	r. talus
g-52	l. calcaneus
g-53	r. calcaneus
g-54	l. #4 metatarsal
g-55	l. #5 metatarsal
g-56	l. #3 metacarpal
g-57	l. #2 metatarsal
g-58	r. #4 metatarsal
g-59	r. #1 metacarpal
g-60	r. #5 metatarsal
g-61	l. #3 metatarsal
g-62	l. #1 metatarsal
g-63	l. cuboid
g-64	#5 phalanges
g-65	Bison, l. mandibular first molar
g-66	mammalian rib fragment
g-67	unidentified mammalian bone fragment
g-68	unidentified mammalian ulna fragment
g-69	Bison, l. astragalus
g-70	unidentified mammalian bone fragment
g-71	Bison, #2 phalanx
g-72	unidentified mammalian bone fragment

DACW4587M0274

Howes (39HU203)

exhibit H - catalogue #8

item #	description
h-1	damaged mandible
h-2	damaged cranium
h-3	damaged l. zygomatic/maxilla
h-4	damaged r. zygomatic/maxilla
h-5	damaged r. maxilla
h-6	#7 miscellaneous cranial fragments
h-7	#6 miscellaneous teeth, permanent
h-8	damaged r. femur
h-9	fragmentary r. humerus
h-10	fragmentary r. ulna
h-11	fragmentary r. radius
h-12	fragmentary r. tibia
h-13	fragmentary r. fibula
h-14	damaged axis
h-15	atlas
h-16	damaged thoracic vertebra
h-17	damaged lumbar vertebra, L5
h-18	damaged lumbar vertebra
h-19	damaged thoracic vertebra
h-20	damaged thoracic vertebra
h-21	damaged thoracic vertebra
h-22	damaged thoracic vertebra
h-23	fragmentary thoracic vertebra
h-24	damaged thoracic vertebra
h-25	damaged cervical vertebra
h-26	damaged cervical vertebra
h-27	fragmentary cervical vertebra
h-28	lumbar vertebra fragment
h-29	lumbar vertebra fragment
h-30	lumbar vertebra fragment
h-31	fragmentary cervical vertebra
h-32	vertebral fragment
h-33	vertebral fragment
h-34	vertebral fragment
h-35	#6 vertebral fragments
h-36	fragmentary sacrum
h-37	fragmentary r. innominate
h-38	fragmentary l. innominate
h-39	damaged r. clavicle
h-40	damaged l. clavicle
h-41	damaged r. scapula

DACW4587M0274

Howes (39HU203)

exhibit H - catalogue #8

item #	description
h-42	damaged l. scapula
h-43	l. #1 metatarsal
h-44	r. #5 metatarsal
h-45	l. #3 metacarpal
h-46	r. #3 metatarsal
h-47	#10 scapula fragments
h-48	innominate fragment (ischio-pubic ramus)
h-49	fragmentary l. rib
h-50	fragmentary l. rib
h-51	fragmentary l. rib
h-52	fragmentary r. rib
h-53	rib fragment
h-54	fragmentary r. rib
h-55	rib fragment
h-56	damaged l. #1 rib
h-57	fragmentary r. rib
h-58	fragmentary l. rib
h-59	fragmentary l. rib
h-60	fragmentary r. rib
h-61	rib fragment
h-62	fragmentary l. rib
h-63	fragmentary r. rib
h-64	fragmentary l. rib
h-65	damaged r. #1 rib
h-66	fragmentary r. rib
h-67	fragmentary r. rib
h-68	fragmentary r. rib
h-69	rib fragment
h-70	fragmentary l. rib
h-71	fragmentary l. rib
h-72	fragmentary l. rib
h-73	fragmentary r. rib
h-74	fragmentary l. rib
h-75	rib fragment
h-76	rib fragment
h-77	#24 miscellaneous bone fragments

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Blue Blanket Point (39WW98)

exhibit I - catalogue #9/10

item #	description
i-1	adult cranium
i-2	damaged adult cranium
i-3	adult mandible
i-4	adult mandible
i-5	damaged juvenile skull
i-6	#30 miscellaneous teeth, permanent & deciduous
i-7	damaged r. innominate
i-8	#274 miscellaneous bone fragments
i-9	damaged l. scapula
i-10	damaged r. scapula
i-11	damaged l. scapula
i-12	damaged l. scapula
i-13	damaged r. scapula
i-14	damaged r. scapula
i-15	damaged r. scapula
i-16	damaged l. innominate
i-17	damaged l. innominate
i-18	damaged r. innominate
i-19	damaged l. innominate
i-20	damaged r. innominate
i-21/46	damaged r. humerus
i-22	damaged r. innominate
i-23	fragmentary ilium/sacrum
i-24	fragmentary pubis
i-25	fragmentary pubis
i-26	fragmentary ilium
i-27	fragmentary juvenile ilium
i-28	fragmentary sternum (manubrium)
i-29	fragmentary ilium (auricular surface)
i-30	damaged r. fibula
i-31	damaged l. fibula
i-32	right fibula
i-33	damaged l. ulna
i-34	damaged l. ulna
i-35	damaged r. radius
i-36	damaged r. fibula
i-37	damaged l. ulna
i-38	r. radius
i-39	fragmentary fibula (shaft)
i-40	damaged r. ulna
i-41	damaged r. ulna

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Blue Blanket Point (39WW98)

exhibit I - catalogue #9/10

item #	description
i-42	r. humerus
i-43	r. humerus
i-44	r. humerus
i-45	l. humerus
i-46	fragmentary humerus (shaft)
i-47	l. tibia
i-48	r. humerus
i-49	damaged r. tibia
i-50	l. tibia
i-51	r. tibia
i-52	l. tibia
i-53	l. femur
i-54	r. radius
i-55	r. femur
i-56	l. femur
i-57	r. femur
i-58	damaged r. tibia
i-59	#17 vertebral fragments
i-60	#13 juvenile vertebral fragments (2 centra, 11 arch halves)
i-61	#5 cervical vertebrae fragments
i-62	#6 thoracic vertebrae fragments
i-63	lumbar vertebra
i-64	lumbar vertebra
i-65	fragmentary lumbar vertebra
i-66	cervical vertebra
i-67	axis
i-68	atlas
i-69	cervical vertebra
i-70	damaged cervical vertebra
i-71	#2 thoracic vertebrae (ankylosed)
i-72	thoracic vertebra (T11)
i-73	thoracic vertebra
i-74	thoracic vertebra
i-75	thoracic vertebra
i-76	thoracic vertebra
i-77	thoracic vertebra
i-78	thoracic vertebra
i-79	fragmentary lumbar vertebra
i-80	fragmentary juvenile vertebra
i-81	#76 rib fragments
i-82	r. rib
i-83	l. rib fragment
i-84	damaged l. rib

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Blue Blanket Point (39WW98)

exhibit I - catalogue #9/10

item #	description
i-85	fragmentary l. rib
i-86	l. rib
i-87	l. rib
i-88	fragmentary r. rib
i-89	fragmentary l. rib
i-90	damaged l. rib
i-91	fragmentary l. rib
i-92	fragmentary r. rib
i-93	fragmentary l. rib
i-94	fragmentary l. rib
i-95	damaged l. rib
i-96	l. rib
i-97	damaged l. rib
i-98	fragmentary l. rib
i-99	damaged l. rib
i-100	damaged l. rib
i-101	fragmentary l. rib
i-102	damaged l. rib
i-103	damaged l. rib
i-104	damaged l. rib
i-105	fragmentary l. rib
i-106	fragmentary l. rib
i-107	fragmentary r. rib
i-108	fragmentary r. rib
i-109	fragmentary r. rib
i-110	fragmentary r. rib
i-111	fragmentary r. rib
i-112	r. rib
i-113	l. rib
i-114	fragmentary r. rib
i-115	fragmentary r. rib
i-116	fragmentary r. rib
i-117	damaged r. rib
i-118	fragmentary l. rib
i-119	damaged r. rib
i-120	fragmentary l. rib
i-121	fragmentary r. rib
i-122	damaged r. rib
i-123	damaged l. rib
i-124	damaged r. rib
i-125	damaged r. rib
i-126	damaged r. rib
i-127	damaged l. rib

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Blue Blanket Point (39WW98)

exhibit I - catalogue #9/10

item #	description
i-128	damaged r. rib
i-129	fragmentary r. rib
i-130	r. rib
i-131	r. rib
i-132	r. rib
i-133	fragmentary r. rib, juvenile
i-134	rib fragment, juvenile
i-135	fragmentary l. rib, juvenile
i-136	rib fragment, juvenile
i-137	fragmentary r. rib, juvenile
i-138	fragmentary r. rib, juvenile
i-139	fragmentary r. rib, juvenile
i-140	rib fragment, juvenile
i-141	rib fragment, juvenile
i-142	fragmentary l. rib, juvenile
i-143	rib fragment, juvenile
i-144	rib fragment, juvenile
i-145	rib fragment, juvenile
i-146	rib fragment, juvenile
i-147	rib fragment
i-148	fragmentary clavicle, juvenile
i-149	#14 long bone fragments, juvenile
i-150	l. femur, juvenile
i-151	fragmentary fibula
i-152	damaged l. clavicle
i-153	damaged r. clavicle
i-154	fragmentary r. tibia, juvenile
i-155	fragmentary l. humerus, juvenile
i-156	fragmentary fibula, juvenile
i-157	fragmentary humerus
i-158	fragmentary tibia
i-159	fragmentary radius, juvenile
i-160	fragmentary r. ulna, juvenile
i-161	fragmentary r. femur, juvenile
i-162	fragmentary l. femur, juvenile
i-163	r. patella
i-164	r. talus
i-165	sternum (body)
i-166	l. talus
i-167	fragmentary r. patella
i-168	l. #5 metatarsal
i-169	damaged r. #5 metatarsal
i-170	r. #2 metatarsal

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Blue Blanket Point (39WW98)

exhibit I - catalogue #9/10

item #	description
i-171	l. #3 metatarsal
i-172	l. #4 metatarsal
i-173	fragmentary metatarsal
i-174	fragmentary metatarsal
i-175	fragmentary r. navicular
i-176	fragmentary sternum
i-177	fragmentary l. rib
i-178	#10 carpal/tarsal phalanges
i-179	fragmentary l. talus
i-180	fragmentary sacrum
i-181	#6 sacral fragments
i-182	#3 modified bird bone tubes
i-183	#2 modified flaking debris
i-184	#7 unmodified pebbles
i-185	Lampsilis, r. valve
i-186	unidentified mammalian long bone fragment
i-187	unidentified mammalian long bone fragment

DACW4587M0274

Blue Blanket Point (39WW98)

exhibit J - catalogue #11

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item #	description
j-1	damaged cranium, juvenile
j-2	fragmentary mandible, juvenile
j-3	#12 miscellaneous teeth, permanent
j-4	thoracic vertebra, juvenile
j-5	thoracic vertebra, juvenile
j-6	atlas, juvenile
j-7	cervical vertebra, juvenile
j-8	thoracic vertebra, juvenile
j-9	axis, juvenile
j-10	thoracic vertebra, juvenile
j-11	damaged thoracic vertebra, juvenile
j-12	cervical vertebra, juvenile
j-13	cervical vertebra, juvenile
j-14	thoracic vertebra, juvenile
j-15	damaged thoracic vertebra, juvenile
j-16	damaged thoracic vertebra, juvenile
j-17	fragmentary thoracic vertebra, juvenile
j-18	#3 miscellaneous vertebral fragments, juvenile
j-19	fragmentary thoracic vertebra, juvenile
j-20	damaged r. scapula, juvenile
j-21	fragmentary femur. juvenile
j-22	r. humerus fragment, juvenile
j-23	damaged l. scapula, juvenile
j-24	fragmentary l. clavicle, juvenile
j-25	metacarpal, juvenile
j-26	fragmentary l. humerus, juvenile
j-27	damaged r. clavicle, juvenile
j-28	fragmentary l. humerus, juvenile
j-29	l. femur (distal epiphysis)
j-30	sternal element, juvenile
j-31	femur fragment, juvenile
j-32	proximal carpal phalanx, juvenile
j-33	proximal carpal phalanx, juvenile
j-34	proximal tarsal phalanx, juvenile
j-35	r. #1 rib, juvenile
j-36	l. rib, juvenile
j-37	r. rib, juvenile
j-38	l. rib, juvenile
j-39	l. rib, juvenile
j-40	l. rib, juvenile
j-41	l. rib, juvenile

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Blue Blanket Point (39WW98)

exhibit J - catalogue #11

item #	description
j-42	r. rib, juvenile
j-43	fragmentary l. rib, juvenile
j-44	l. rib, juvenile
j-45	fragmentary l. rib, juvenile
j-46	#24 miscellaneous rib fragments
j-47	#44 miscellaneous bone fragments

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Pike Haven Recreation Area

exhibit K - catalogue #12

item #	description
k-1	subadult cranium

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Donahue (39LM27)

exhibit L - catalogue #13

item #	description
1-1	calvarium (occipital, l&r parietal)
1-2	fragmentary frontal
1-3	l. parietal
1-4	damaged l. parietal
1-5	occipital fragment
1-6	fragmentary r. parietal
1-7	occipital fragment
1-7	occipital fragment
1-8	fragmentary l. parietal
1-9	fragmentary l. parietal
1-10	fragmentary r. parietal
1-11	parietal fragment
1-12	fragmentary r. parietal
1-13	fragmentary parietal
1-14	fragmentary l. parietal
1-15	#11 miscellaneous cranial fragments

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Brush Creek Area

exhibit M - catalogue #14

item #	description
m-1	damaged cranium
m-2	damaged mandible
m-3	#5 cranial fragments
m-4	damaged l. ulna
m-5	damaged r. fibula
m-6	damaged r. tibia
m-7	damaged l. humerus
m-8	r. radius
m-9	damaged l. fibula
m-10	damaged l. tibia
m-11	damaged l. femur
m-12	r. humerus
m-13	l. radius
m-14	r. ulna
m-15	damaged r. femur
m-16	damaged r. innominate
m-17	fragmentary r. rib
m-18	fragmentary r. rib
m-19	fragmentary r. rib
m-20	fragmentary r. rib
m-21	fragmentary r. rib
m-22	fragmentary r. rib
m-23	#12 rib fragments
m-24	damaged l. metacarpal
m-25	damaged l. patella
m-26	damaged r. patella
m-27	fragmentary r. scapula
m-28	fragmentary atlas
m-29	damaged r. clavicle
m-30	damaged l. #1 metacarpal
m-31	damaged l. #2 metacarpal
m-32	l. #3 metacarpal
m-33	fragmentary l. clavicle
m-34	damaged l. navicular
m-35	damaged l. lunate
m-36	damaged l. capitate
m-37	damaged l. triquetral
m-38	damaged axis
m-39	#12 phalanges
m-40	#4 vertebral fragments
m-41	#12 miscellaneous bone fragments

DACW4587M0274

Elm Creek Recreation Area

exhibit N - catalogue #15

item #	description
n-1	r. radius, juvenile
n-2	r. tibia, juvenile
n-3	damaged fibula, juvenile
n-4	fragmentary l. tibia, juvenile
n-5	damaged l. femur
n-6	damaged r. humerus
n-7	damaged r. femur
n-8	fragmentary r. tibia
n-9	r. tibia
n-10	damaged l. tibia
n-11	l. fibula
n-12	#9 miscellaneous bone fragments
n-13	Bison, r. metatarsal fragment
n-14	Bison, r. metatarsal fragment
n-15	Bison, r. metatarsal fragment

DACW4587M0274

Blue Blanket Point (39WW98)

exhibit O - catalogue #16

item #	description
o-1	#22 vertebral fragments, juvenile
o-2	#30 teeth, permanent
o-3	#173 miscellaneous bone fragments
o-4	#39 rib fragments
o-5	#10 phalanges, juvenile
o-6	damaged skull, subadult
o-7	coracoid process (epiphysis)
o-8	distal tibia (epiphysis)
o-9	#2 metatarsals, juvenile
o-10	damaged sternum (manubrium), juvenile
o-11	#10 metacarpals, juvenile
o-12	fragmentary r. ulna, juvenile
o-13	fragmentary l. ulna, juvenile
o-14	fragmentary femur, juvenile
0-15	damaged r. patella, juvenile
o-16	fragmentary r. humerus, juvenile
o-17	fragmentary r. scapula, juvenile
o-18	proximal epiphysis r. humerus
o-19	fragmentary scapula, juvenile
o-20	fragmentary l. radius, juvenile
o-21	fragmentary l. clavicle, juvenile
o-22	fragmentary l. radius, juvenile
o-23	fragmentary ulna, juvenile
o-24	fragmentary humerus, juvenile
o-25	#19 miscellaneous long bone fragments, juvenile
o-26	#6 dentalium shells
o-27	shell bead
o-28	flat shell ring
o-29	mammal bone bead
o-30	wood fragments

DACW4587M0274

Okobojo Point

exhibit P - catalogue #17

item #	description
p-1	damaged l. ulna, juvenile
p-2	r. ulna, juvenile
p-3	damaged l. radius, juvenile
p-4	damaged r. radius, juvenile
p-5	damaged r. humerus, juvenile
p-6	damaged l. humerus, juvenile
p-7	fragmentary r. femur, juvenile
p-8	fragmentary r. clavicle, juvenile
p-9	#19 rib fragments, juvenile
p-10	r. rib fragment, juvenile
p-11	r. rib fragment, juvenile
p-12	fragmentary r. rib, juvenile
p-13	r. rib fragment, juvenile
p-14	r. rib fragment, juvenile
p-15	r. rib fragment, juvenile
p-16	r. rib fragment, juvenile
p-17	r. rib fragment, juvenile
p-18	r. rib fragment, juvenile
p-19	fragmentary r. rib, juvenile
p-20	r. rib fragment, juvenile
p-21	fragmentary r. rib, juvenile
p-22	r. rib fragment , juvenile
p-23	fragmentary l. rib, juvenile
p-24	fragmentary r. rib, juvenile
p-25	l. rib fragment, juvenile
p-26	l. rib fragment, juvenile
p-27	l. rib fragment, juvenile
p-28	l. rib fragment, juvenile
p-29	l. rib fragment, juvenile
p-30	fragmentary l. rib, juvenile
p-31	fragmentary l. rib, juvenile
p-32	l. rib fragment, juvenile
p-33	l. rib fragment, juvenile
p-34	fragmentary l. rib, juvenile
p-35	fragmentary l. rib, juvenile
p-36	l. rib fragment, juvenile
p-37	r. rib fragment, juvenile
p-38	fragmentary l. rib, juvenile
p-39	fragmentary l. rib, juvenile
p-40	r. rib fragment, juvenile
p-41	damaged r. scapula, juvenile

DACW4587M0274

Okobojo Point

exhibit P - catalogue #17

item #	description
p-42	damaged l. ilium, juvenile
p-43	fragmentary r. ilium, juvenile
p-44	fragmentary r. ischium, juvenile
p-45	ilium fragment. juvenile
p-46	fragmentary atlas, juvenile
p-47	#43 vertebral fragments, juvenile
p-48	fragmentary l. calcaneus, juvenile
p-49	#24 miscellaneous teeth, deciduous
p-50	fragmentary mandible, juvenile
p-51	fragmentary l. maxilla, juvenile
p-52	fragmentary r. calcaneus, juvenile
p-53	scapula fragment (coracoid epiphysis)
p-54	#7 miscellaneous long bone fragments, juvenile
p-55	#6 metatarsal/metacarpal, juvenile
p-56	tibial fragment, juvenile
p-57	femur fragment, juvenile
p-58	tibial fragment, juvenile
p-59	tibial fragment, juvenile
p-60	femur fragment, juvenile
p-61	femur fragment, juvenile
p-62	humerus fragment, juvenile
p-63	tibial fragment, juvenile
p-64	#72 miscellaneous bone fragments
p-65	frontal fragment, juvenile
p-66	l. parietal, juvenile
p-67	r. parietal, juvenile
p-68	r. temporal, juvenile
p-69	occipital, juvenile
p-70	#30 cranial fragments
p-71	#85 perforated shaped teeth, faunal?
p-72	#2 bird bone whistles
p-73	perforated radius, faunal
p-74	unidentified mammalian bone fragment
p-75	#9 <u>Bufo</u> elements

DACW4587M0274

LeCompte Catholic Cemetery

exhibit Q - catalogue #18

item #	description
q-1	r. innominate
q-2	fragmentary l. innominate

DACW4587M0274

Prairie Dog Bay

exhibit R - catalogue #19

item #	description
r-1	r. femur
r-2	r. tibia
r-3	l. femur
r-4	l. tibia

DACW4587M0274

39LM59

exhibit S - catalogue #20A

item #	description
s-1	r. innominate
s-2	fragmentary l. ulna
s-3	l. innominate
s-4	r. rib fragment
s-5	r. rib
s-6	r. rib
s-7	r. rib
s-8	l. talus
s-9	l. clavicle
s-10	damaged sternum (manubrium)
s-11	damaged thoracic vertebra
s-12	cervical vertebra
s-13	damaged cervical vertebra
s-14	#5 vertebral fragments
s-15	l. talus
s-16	#8 phalanges
s-17	fragmentary r. innominate
s-18	r. #4 metacarpal
s-19	l. #2 metacarpal
s-20	r. #5 metacarpal
s-21	l. #4 metacarpal
s-22	damaged metacarpal
s-23	l. #3 metacarpal
s-24	#4 miscellaneous bone fragments
s-25	r. triquetral
s-26	r. scapula fragment
s-27	fragmentary lumbar vertebra
s-28	l. rib fragment
s-29	l. hamate
s-30	#20 miscellaneous bone fragments
s-31	sternum (body)
s-32	l. #1 metacarpal
s-33	r. navicular
s-34	l. greater multangular
s-35	r. hamate
s-36	damaged l. #2 metacarpal
s-37	damaged metacarpal
s-38	r. #1 metacarpal
s-39	r. #5 metacarpal
s-40	l. hamate
s-41	r. capitate

DACW4587M0274

39LM59

exhibit S - catalogue #20A

item #	description
s-42	l. navicular
s-43	r. lesser multangular
s-44	r. lunate
s-45	damaged l. calcaneus
s-46	#9 phalanges
s-47	l. innominate
s-48	fragmentary thoracic vertebra
s-49	fragmentary thoracic vertebra
s-50	damaged lumbar vertebra
s-51	damaged lumbar vertebra
s-52	damaged lumbar vertebra
s-53	damaged lumbar vertebra
s-54	fragmentary thoracic vertebra
s-55	fragmentary thoracic vertebra
s-56	fragmentary thoracic vertebra
s-57	fragmentary thoracic vertebra
s-58	fragmentary thoracic vertebra
s-59	#4 vertebral fragments
s-60	damaged sacrum
s-61	fragmentary lumbar vertebra
s-62	cervical vertebra
s-63	fragmentary thoracic vertebra
s-64	fragmentary thoracic vertebra
s-65	l. rib
s-66	fragmentary r. rib
s-67	fragmentary r. rib
s-68	fragmentary r. rib
s-69	fragmentary r. rib
s-70	fragmentary r. rib
s-71	fragmentary r. rib
s-72	#8 rib fragments
s-73	#100 miscellaneous bone fragments
s-74	damaged l. radius
s-75	damaged r. clavicle
s-76	r. #2 metacarpal
s-77	damaged r. #3 metacarpal
s-78	r. #1 metacarpal
s-79	l. #4 metacarpal
s-80	fragmentary thoracic vertebra
s-81	fragmentary l. scapula
s-82	l. scapula fragment
s-83	r. rib fragment
s-84	proximal carpal phalanx

DACW4587M0274

39LM59

exhibit S - catalogue #20A

item #	description
s-85	#9 vertebral fragments
s-86	#29 miscellaneous bone fragments
s-87	r. rib fragment
s-88	r. rib fragment
s-89	r. rib fragment
s-90	r. rib fragment
s-91	fragmentary r. rib
s-92	fragmentary r. rib
s-93	fragmentary l. rib
s-94	fragmentary l. rib
s-95	fragmentary l. rib
s-96	fragmentary l. rib
s-97	fragmentary l. rib
s-98	#19 rib fragments
s-99	#4 body sherds
s-100	retouched flake
s-101	#2 charcoal fragments

DACW4587M0274

Fort Lookout II (39LM57)

exhibit T - catalogue #20B

item #	description
t-1	damaged r. femur
t-2	#2 miscellaneous teeth, permanent
t-3	fragmentary frontal, juvenile
t-4	fragmentary occipital, juvenile
t-5	damaged mandible
t-6	fragmentary l. mandible, juvenile
t-7	fragmentary atlas
t-8	maxilla & r. zygomatic
t-9	fragmentary sphenoid
t-10	fragmentary l. temporal
t-11	rodent skull fragment
t-12	#11 unidentified mammalian bone fragments

DACW4587M0274

Scalp Creek Cemetery (39GR32)

exhibit U - catalogue #21

item #	description
u-1	#2 l. femur fragments
u-2	#4 parietal fragments
u-3	#3 skull fragments
u-4	#18 r. ulna fragments
u-5	#1 miscellaneous tooth, permanent
u-6	#4 occipital fragments
u-7	r. rib fragment
u-8	#9 skull fragments
u-9	#32 r. humerus fragments, juvenile
u-10	#5 miscellaneous cranial fragments
u-11	#6 miscellaneous cranial fragments
u-12	#3 vertebral fragments
u-13	#2 miscellaneous bone fragments
u-14	miscellaneous cranial fragment
u-15	#4 miscellaneous cranial fragments
u-16	#4 miscellaneous cranial fragments
u-17	fragmentary occipital/parietals
u-18	#4 miscellaneous cranial fragments
u-19	#5 miscellaneous cranial fragments
u-20	fragmentary frontal
u-21	#9 miscellaneous cranial fragments
u-22	bone fragments w/soil matrix
u-23	#2 miscellaneous cranial fragments
u-24	#3 miscellaneous cranial fragments
u-25	#2 miscellaneous cranial fragments
u-26	#5 miscellaneous cranial fragments
u-27	#6 miscellaneous bone fragments
u-28	#3 miscellaneous cranial fragments
u-29	#3 miscellaneous cranial fragments
u-30	#10 miscellaneous bone fragments
u-31	#10 miscellaneous cranial fragments

DACW4587M0274

39LM256

exhibit V - catalogue #22

item #	description
v-1	l. femur
v-2	l. femur
v-3	l. femur
v-4	r. femur
v-5	damaged l. tibia
v-6	fragmentary r. femur
v-7	damaged r. tibia
v-8	damaged r. fibula
v-9	r. femur
v-10	fragmentary l. femur
v-11	#3 miscellaneous teeth, permanent
v-12	damaged l. humerus
v-13	damaged l. ulna
v-14	damaged r. humerus
v-15	damaged r. radius
v-16	damaged r. radius
v-17	damaged l. radius
v-18	l. humerus fragment
v-19	r. tibia fragment
v-20	fragmentary r. ulna
v-21	fragmentary l. humerus
v-22	mandible fragment
v-23	r. ulna fragment
v-24	l. ulna fragment
v-25	cervical vertebra
v-26	l. femur fragment, juvenile
v-27	r. tibia, juvenile
v-28	fragmentary humerus, juvenile
v-29	r. ulna, juvenile
v-30	ilium, juvenile
v-31	vertebral arch, juvenile
v-32	metatarsal fragment, juvenile
v-33	fragmentary l. rib, juvenile
v-34	r. rib fragment
v-35	l. rib, juvenile
v-36	fragmentary r. rib, juvenile
v-37	l. rib, juvenile
v-38	#5 rib fragments
v-39	damaged r. calcaneus
v-40	#5 miscellaneous bone fragments
v-41	# cranial fragments, juvenile

DACW4587M0274

39LM256

exhibit V - catalogue #22

item #	description
v-42	fragmentary cranium
v-43	mandible
v-44	fragmentary cranium
v-45	fragmentary cranium
v-46	#2 miscellaneous teeth, permanent
v-47	fragmentary cranium
v-48	fragmentary mandible
v-49	#3 rib fragments, juvenile
v-50	#2 longbone fragments
v-51	damaged cervical vertebra, juvenile
v-52	fragmentary cranium
v-53	#1 miscellaneous longbone fragment
v-54	#2 miscellaneous teeth, permanent
v-55	metacarpal, juvenile
v-56	ischium fragment
v-57	damaged l. innominate
v-58	damaged l. scapula
v-59	damaged l. innominate
v-60	r. innominate
v-61	#2 miscellaneous teeth, deciduous
v-62	fragmentary cranium, juvenile
v-63	#52 miscellaneous bone fragments
v-64	tibia fragment
v-65	radius fragment
v-66	fragmentary thoracic vertebra
v-67	#45 miscellaneous bone fragments
v-68	fragmentary cranium
v-69	#35 miscellaneous cranial fragments
v-70	sphenoid fragment
v-71	#3 vertebral fragments
v-72	#3 rib fragments, juvenile
v-73	fragmentary ischium, juvenile
v-74	fragmentary calcaneus
v-75	fragmentary femur, juvenile
v-76	#2 centra, juvenile
v-77	carpal, juvenile
v-78	small stone biface
v-79	modified scapula fragment, faunal
v-80	#2 modified gastropod shells
v-81	pointed spatulate rib tool, faunal
v-82	unidentified snail shell
v-83	unidentified rodent, l. femur

DACW4587M0274

39ST126

exhibit W - catalogue #23

item #	description
w-1	r. femur
w-2	l. femur
w-3	r. tibia
w-4	#8 miscellaneous teeth, permanent
w-5	damaged sacrum
w-6	damaged l. innominate
w-7	#3 r. ischial fragments
w-8	ischial fragment
w-9	damaged l. scapula
w-10	fragmentary l. rib
w-11	fragmentary l. rib
w-12	fragmentary l. rib
w-13	fragmentary l. rib
w-14	fragmentary l. rib
w-15	fragmentary l. rib
w-16	l. rib fragment
w-17	l. rib fragment
w-18	l. rib fragment
w-19	r. rib fragment
w-20	r. rib fragment
w-21	l. rib fragment
w-22	l. rib fragment
w-23	femoral condyle
w-24	r. humerus
w-25	damaged r. radius
w-26	damaged r. ulna
w-27	damaged l. ulna
w-28	damaged fibula
w-29	damaged l. humerus
w-30	damaged l. radius
w-31	damaged fibula
w-32	damaged l. clavicle
w-33	damaged r. clavicle
w-34	damaged l. calcaneus
w-35	damaged r. talus
w-36	damaged l. talus
w-37	damaged r. #5 metatarsal
w-38	damaged l. #5 metatarsal
w-39	damaged r. #1 metatarsal
w-40	damaged l. #4 metatarsal
w-41	#5 metatarsal/metacarpal fragments

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39ST126

exhibit W - catalogue #23

item #	description
w-42	fragmentary maxilla
w-43	fragmentary mandible
w-44	lumbar vertebra
w-45	damaged lumbar vertebra
w-46	damaged lumbar vertebra
w-47	damaged thoracic vertebra
w-48	damaged thoracic vertebra
w-49	damaged thoracic vertebra
w-50	damaged thoracic vertebra
w-51	damaged thoracic vertebra
w-52	damaged thoracic vertebra
w-53	damaged thoracic vertebra
w-54	damaged thoracic vertebra
w-55	#8 rib fragments
w-56	#4 vertebral fragments
w-57	#64 miscellaneous bone fragments
w-58	damaged cervical vertebra
w-59	cervical vertebra
w-60	damaged cervical vertebra
w-61	damaged thoracic vertebra
w-62	damaged thoracic vertebra
w-63	fragmentary r. calcaneus
w-64	#2 limonite concretion fragments

DACW4587M0274

39BR13

exhibit X - catalogue #25

item #	description
x-1	r. parietal
x-2	damaged l. parietal
x-3	damaged frontal
x-4	damaged l. scapula
x-5	r. rib
x-6	r. rib
x-7	damaged r. innominate
x-8	l. radius
x-9	l. tibia
x-10	l. femur
x-11	r. tibia
x-12	fragmentary l. humerus
x-13	damaged r. innominate
x-14	scapula hoe fragment, faunal

DACW4587M0274

exhibit X - catalogue #26

item #	description
x-14	damaged cranium
x-15	damaged cranium

DACW4587M0274

Sunrise Hill (39CH210)

exhibit Y - catalogue #27

item #	description
y-1	fragmentary r. femur
y-2	fragmentary l. femur
y-3	fragmentary mandible
y-4	damaged l. patella
y-5	fragmentary r. humerus
y-6	fragmentary l. tibia
y-7	fragmentary r. ulna
y-8	fragmentary r. humerus
y-9	fragmentary l. clavicle
y-10	fragmentary r. scapula
y-11	#159 miscellaneous bone fragments
y-12	#6 rib fragments
y-13	#9 vertebral fragments
y-14	fragmentary frontal
y-15	r. maxillary fragment
y-16	#2 r. ulna fragments
y-17	r. ulna fragment
y-18	r. ulna fragment
y-19	r. clavicle fragment
y-20	#10 miscellaneous teeth, permanent
y-21	#2 cranial fragments
y-22	fragmentary r. zygomatic
y-23	damaged r. talus
y-24	damaged l. talus
y-25	damaged r. calcaneus
y-26	damaged l. calcaneus
y-27	fragmentary navicular
y-28	damaged r. #1 metatarsal
y-29	damaged l. #1 metatarsal
y-30	damaged r. #2 metatarsal
y-31	damaged l. #3 metatarsal
y-32	damaged l. #4 metatarsal
y-33	damaged r. #4 metatarsal
y-34	damaged l. #5 metatarsal
y-35	fragmentary r. #2 cuneiform
y-36	#5 fragmentary phalanges
y-37	fragmentary humerus
y-38	#1 longbone fragment
y-39	unidentified mammalian bone fragment

DACW4587M0274

Walth Bay (39WW203)

exhibit Z - catalogue #28

item #	description
z-1	damaged cranium

DACW4587M0274

exhibit AA - catalogue #29

item #	description
aa-1	damaged cranium

DACW4587M0274

Brule Flat Village (39BR10)

exhibit BB - catalogue #30

item #	description
bb-1	damaged r. parietal
bb-2	fragmentary l. fibula
bb-3	damaged occipital
bb-4	occipital fragment

APPENDIX C

Permanent Visual Records on File at the Omaha District Corps of Engineers

1. black and white negatives
2. color transparencies
3. dental casts

1. black and white negatives

roll # 1

exposure #	description
24A	39C034 - r. tibia, periosteal reaction
25A	39C034 - r. tibia, periosteal reaction
26A	39CA4 - r. femur, periosteal reaction
27A	39CA4 - r. tibia, ossified ligament
28A	39LM59 - r. innominate, parturition pitting
29A	39LM57 - r. femur, periosteal reaction
30A	39LM57 - r. femur, periosteal reaction
31A	39LM57 - r. femur, periosteal reaction
32A	39LM256 - r. femur, erosive pit, medial condyle
33A	39LM256 - r. femur, cut marks, head

roll # 2

exposure #	description
2	39C034 - cranium, superior
3	39C034 - cranium, l. lateral
4	39C034 - cranium, r. lateral
5	39C034 - cranium, basal
6	39C034 - cranium, frontal
7	39C034 - cranium, occipital
8	39C034 - cranium, interproximal groove/caries
9	39C034 - mandible
10	39C034 - osteophytosis, L4
11	39C034 - osteophytosis, L5
12	39CA4 (no. 2A) - hypermuscular l/r ulnae
13	39CA4 (no. 2B) - r. tibia, periostitis
14	39CA4 (no. 2B) - osteosclerotic reaction, l. femur
15	39CA4 (no. 2B) - osteosclerotic reaction, l. clavicle
16	39SL4 - cranium (c-1), superior
17	39SL4 - cranium (c-1), superior (close-up)
18	39SL4 - cranium (c-1), l. lateral
19	39SL4 - cranium (c-1), r. lateral
20	39SL4 - cranium (c-1), basal
21	39SL4 - cranium (c-1), frontal
22	39SL4 - cranium (c-1), occipital
23	39SL4 - cranium (c-1), interproximal groove
24	39SL4 - cranium (c-2), superior
25	39SL4 - cranium (c-2), l. lateral
26	39SL4 - cranium (c-2), r. lateral
27	39SL4 - cranium (c-2), basal
28	39SL4 - cranium (c-2), frontal
29	39SL4 - cranium (c-2), occipital
30	39SL4 - cranium (c-2), caries
31	39SL4 - cranium (c-2), caries
32	39SL4 - cranium (c-2), periosteal reaction
33	39SL4 - cranium (c-2), excessive calculus deposits
34	blue blanket recreation area - cranium (d-1), l. lateral
35	blue blanket recreation area - cranium (d-1), r. lateral
36	blue blanket recreation area - cranium (d-1), superior
37	blue blanket recreation area - cranium (d-1), superior

roll # 3

exposure #	description
7A	blue blanket recreation area - cranium (d-1), basal
8A	blue blanket recreation area - cranium (d-1), frontal
9A	blue blanket recreation area - cranium (d-1), occipital
10A	blue blanket recreation area - cranium (d-1), abscess
11A	blue blanket recreation area - cranium (d-1), hypoplasia
12A	blue blanket recreation area - cranium (d-1), hypoplasia
13A	blue blanket recreation area - cranium (d-1), caries
14A	blue blanket recreation area - ossified ligament, r tibia
15A	artifacts (see text, pp. 153)
16A	artifacts (see text, pp. 153)
17A	artifacts (see text, pp. 153)
18A	artifacts (see text, pp. 155)
19A	artifacts (see text, pp. 155)
20A	artifacts (see text, pp. 155)
21A	artifacts (see text, pp. 157)
22A	artifacts (see text, pp. 157)
23A	artifacts (see text, pp. 157)
24A	blue blanket recreation area - cranium (e-1), r. lateral
25A	blue blanket recreation area - cranium (e-1), l. lateral
26A	blue blanket recreation area - cranium (e-1), superior
27A	blue blanket recreation area - cranium (e-1), basal
28A	blue blanket recreation area - cranium (e-1), frontal
29A	blue blanket recreation area - cranium (e-1), occipital
30A	blue blanket recreation area - cranium (e-1), mandible
31A	blue blanket recreation area - cranium (e-1), periosteal reaction
32A	blue blanket recreation area - cranium (e-1), abscess
33A	blue blanket recreation area - cranium (e-1), caries/abscess
34A	blue blanket recreation area - incineration damage (see text page 40)
35A	blue blanket recreation area - ossified thyroid cartilage
36A	blue blanket recreation area - ossified thyroid cartilage
37A	blue blanket recreation area - rib lesion?
38A	blue blanket recreation area - osteophytosis, L3
39A	blue blanket recreation area - osteophytosis, L2
40A	blue blanket recreation area - degenerative joint disease, l. humerus
41A	blue blanket recreation area - degenerative joint disease, l. radius

roll # 4

exposure #	description
15	exhibit F, catalogue no. 6 - cranium (f-1), r. lateral
16	exhibit F, catalogue no. 6 - cranium (f-1), l. lateral
17	exhibit F, catalogue no. 6 - cranium (f-1), superior
18	exhibit F, catalogue no. 6 - cranium (f-1), basal
19	exhibit F, catalogue no. 6 - cranium (f-1), frontal
20	exhibit F, catalogue no. 6 - cranium (f-1), occipital
21	exhibit F, catalogue no. 6 - cranium (f-1), mandible
22	39WW1 - multiparous r. innominate
23	39WW1 - bone spur, l. calcaneus
24	39WW1 - osteophytosis, L?
25	39WW1 - osteophytosis, L?
26	39WW1 - osteophytosis, sacrum
27	39WW1 - osteophytosis, L?
28	39WW1 - degenerative joint disease, r. tibia
29	39WW1 - degenerative joint disease, r. tibia
30	39WW1 - degenerative joint disease, l. femur
31	39WW1 - degenerative joint disease, r. tibia
32	39HU203 - cranium, superior
33	39HU203 - cranium, periosteal reaction
34	39HU203 - cranium, mandible
35	39HU203 - cranium, caries
36	39HU203 - spina bifida occulta
37	39HU203 - cranium, l. lateral
38	39HU203 - cranium, r. lateral
39	39WW98 - cranium (i-1), r. lateral
40	39WW98 - cranium (i-1), l. lateral
41	39WW98 - cranium (i-1), superior
42	39WW98 - cranium (i-1), basal
43	39WW98 - cranium (i-1), frontal
44	39WW98 - cranium (i-1), occipital
1	39WW98 - cranium (i-1), (close-up) maxilla
2	39WW98 - mandible (i-4)
3	39WW98 - cranium (i-2), r. lateral
4	39WW98 - cranium (i-2), l. lateral
5	39WW98 - cranium (i-2), superior
6	39WW98 - cranium (i-2), basal

roll # 5

exposure #	description
17A	39WW98 - cranium (i-2), inferior
18A	39WW98 - cranium (i-2), occipital
19A	39WW98 - cranium (i-1), sinus abscess
20A	39WW98 - cranium (i-1), abscess
21A	39WW98 - hypermuscularity, l. femur (i-53)
22A	39WW98 - hypermuscularity (close-up), l. femur (i-53)
23A	39WW98 - degenerative joint disease, l. femur
24A	39WW98 - periostitis, r. tibia (i-58)
25A	39WW98 - periostitis, r. tibia (i-58), r. fibula (i-31)
26A	38WW98 - cranium (j-1), r. lateral
27A	38WW98 - cranium (j-1), l. lateral
28A	38WW98 - cranium (j-1), (close-up) periosteal reaction
29A	38WW98 - cranium (j-1), basal
30A	38WW98 - cranium (j-1), superior
31A	38WW98 - cranium (j-1), occipital
32A	38WW98 - mandible (j-2)
33A	38WW98 - cranium (j-1), hypoplasia
34A	pike haven recreation area - cranium (k-1), l. lateral
35A	pike haven recreation area - cranium (k-1), r. lateral
36A	pike haven recreation area - cranium (k-1), basal
37A	pike haven recreation area - cranium (k-1), superior
38A	pike haven recreation area - cranium (k-1), frontal
39A	pike haven recreation area - cranium (k-1), occipital
40A	brush creek area - cranium, l. lateral
41A	brush creek area - cranium, superior
42A	brush creek area - mandible
43A	brush creek area - mandible
44A	elm creek recreation area - periostitis, r. tibia (n-8)
1A	39WW98 - cranium (o-6), r. lateral
2A	39WW98 - cranium (o-6), l. lateral
3A	39WW98 - cranium (o-6), superior
4A	39WW98 - cranium (o-6), hypoplasia
5A	okobojo point - mandible (p-50)
6A	lecompte cemetery - r. innominate
7A	lecompte cemetery - r. innominate, multiparity
8A	prairie dog bay - severe weathering (see text pp.65)

roll # 6

exposure #	description
25A	prairie dog bay - severe weathering (see text page 65)
26A	39LM59 - multiparity (s-47)
27A	39LM59 - multiparity
28A	39LM59 - wedge shaped L2
29A	39LM57 - mandible
30A	39LM57 - maxilla
31A	39LM256 - cranium (v-45), l. lateral
32A	39LM256 - cranium (v-45), r. lateral
33A	39LM256 - cranium (v-45), superior
34A	39LM256 - cranium (v-45), button osteoma
35A	39LM256 - cranium (v-45), periosteal reaction
36A	39LM256 - cranium (v-45), maxilla
37A	39LM256 - cranium (v-45), maxilla
38A	39LM256 - cranium (v-42), malocclusion
39A	39LM256 - mandible (v-43)
40A	39LM256 - cranium (v-68), temporo-mandibular joint
41A	39LM256 - cranium (v-68), temporo-mandibular joint
42A	39LM256 - healed colles fracture, r. radius
43A	39LM256 - healed colles fracture, r. radius
44A	39LM256 - healed colles fracture, r. radius
1A	39BR13 - cranium, superior
2A	39BR13 - cranium, (close-up) periosteal reaction
3A	39BR13 - cranium, (close-up) periosteal reaction
4A	39BR13 - radius, sclerous reaction
5A	x-15 - cranium, superior
6A	x-15 - cranium, l. lateral
7A	x-15 - cranium, r. lateral
8A	x-15 - cranium, basal
9A	x-15 - cranium, frontal
10A	x-15 - cranium, occipital
11A	x-15 - cranium, bifurcated digastric groove
12A	x-14 - cranium, superior
13A	x-14 - cranium, r. lateral
14A	x-14 - cranium, l. lateral
15A	x-14 - cranium, occipital
16A	x-14 - cranium, basal

roll # 7

exposure #	description
37A	39WW203 - cranium, superior
38A	39WW203 - cranium, (close-up) bossing
39A	39WW203 - cranium, (close-up) bossing
40A	platte creek recreation area - cranium, r. lateral
41A	platte creek recreation area - cranium, l. lateral
42A	platte creek recreation area - cranium, superior
43A	platte creek recreation area - cranium, basal
44A	platte creek recreation area - cranium, occipital
1A	platte creek recreation area - cranium, frontal
2A	platte creek recreation area - cranium, caries

roll # 8

exposure #	description
43	39C034, cranium - l. lateral
44	39C034, cranium - l. lateral
1	39WW98, exhibit J, cranium - r. lateral
2	39WW98, exhibit J, cranium - l. lateral
3	39WW98, exhibit J, cranium - superior
4	39WW98, exhibit J, cranium - inferior
5	39WW98, exhibit J, cranium - frontal
6	39WW98, exhibit J, cranium - occipital
7	blue blanket rec. area, ex. D, cranium - frontal
8	blue blanket rec. area, ex. E, ossified thyroid cartilage
9	blue blanket rec. area, ex. E, ossified thyroid cartilage
10	blue blanket rec. area, ex. E, cranium - frontal
11	39WW98, cranium (i-1) - frontal
12	blue blanket rec. area, ex. D, cranium - caries
13	blue blanket rec. area, ex. D, linear enamel hypoplasia
14	39SL4, cranium - osteoporotic pitting
15	blue blanket rec. area, ex. D (d-5) - bone spur
16	blue blanket rec. area, ex. E, osteoporotic pitting
17	39WW1, left calcaneus - bone spur
18	39LM256, cranium (skull A) - button osteoma

2. color transparencies

exposure #	description
1	39C034 - cranium, superior
2	39C034 - cranium, l. lateral
3	39C034 - cranium, r. lateral
4	39C034 - cranium, basal
5	39C034 - cranium, frontal
6	39C034 - cranium, occipital
7	39C034 - cranium, interproximal groove/caries
8	39C034 - mandible
9	39CA4 (no. 2B) - osteosclerotic reaction, l. femur
10	39SL4 - cranium (c-1), superior
11	39SL4 - cranium (c-1), occipital
12	39SL4 - cranium (c-1), l. lateral
13	39SL4 - cranium (c-1), r. lateral
14	39SL4 - cranium (c-1), basal
15	39SL4 - cranium (c-1), frontal
16	39SL4 - cranium (c-2), superior
17	39SL4 - cranium (c-2), l. lateral
18	39SL4 - cranium (c-2), r. lateral
19	39SL4 - cranium (c-2), basal
20	39SL4 - cranium (c-2), frontal
21	39SL4 - cranium (c-2), occipital
22	39CA4 - midshaft periostitis, l. tibia
23	blue blanket recreation area - cranium (d-1), l. lateral
24	blue blanket recreation area - cranium (d-1), r. lateral
25	blue blanket recreation area - cranium (d-1), superior
26	blue blanket recreation area - cranium (d-1), basal
27	blue blanket recreation area - cranium (d-1), frontal
28	blue blanket recreation area - cranium (d-1), occipital
29	blue blanket recreation area - cranium (d-1), abscess/caries
30	blue blanket recreation area - cranium (d-1), hypoplasia
31	blue blanket recreation area - cranium (d-1), hypoplasia
32	blue blanket recreation area - ossified ligament, r tibia
33	blue blanket recreation area - cranium (e-1), r. lateral
34	blue blanket recreation area - cranium (e-1), l. lateral
35	blue blanket recreation area - cranium (e-1), superior
36	blue blanket recreation area - cranium (e-1), basal
37	blue blanket recreation area - cranium (e-1), frontal
38	blue blanket recreation area - cranium (e-1), occipital
39	blue blanket recreation area - cranium (e-1), mandible
40	blue blanket recreation area - cranium (e-1), abscess
41	blue blanket recreation area - cranium (e-1), caries/abscess
42	blue blanket recreation area - ossified thyroid cartilage
43	blue blanket recreation area - ossified thyroid cartilage
44	blue blanket recreation area - incineration damage (see text page 40)

45 blue blanket recreation area - incineration damage (see text page 40)
46 exhibit F, catalogue no. 6 - cranium (f-1), r. lateral
47 exhibit F, catalogue no. 6 - cranium (f-1), l. lateral
48 exhibit F, catalogue no. 6 - cranium (f-1), superior
49 exhibit F, catalogue no. 6 - cranium (f-1), basal
50 exhibit F, catalogue no. 6 - cranium (f-1), frontal
51 exhibit F, catalogue no. 6 - cranium (f-1), occipital
52 exhibit F, catalogue no. 6 - cranium (f-1), mandible
53 39WW1 - multiparous r. innominate
54 39WW1 - bone spur, l. calcaneus
55 39WW1 - r. tibia (individual no. 2), severe degenerative joint disease
56 39WW1 - r. tibia (individual no. 2), severe degenerative joint disease
57 39WW1 - r. tibia (individual no. 2), severe degenerative joint disease
58 39HU203 - cranium, r. lateral
59 39HU203 - cranium, l. lateral
60 39HU203 - cranium, superior
61 39HU203 - cranium, occipital
62 39HU203 - cranium, mandible
63 39HU203 - cranium, caries
64 39HU203 - spina bifida occulta
65 39WW98 - cranium (i-1), r. lateral
66 39WW98 - cranium (i-1), l. lateral
67 39WW98 - cranium (i-1), superior
68 39WW98 - cranium (i-1), basal
69 39WW98 - cranium (i-1), frontal
70 39WW98 - cranium (i-1), occipital
71 39WW98 - cranium (i-1), (close-up) maxilla, sinus abscess
72 39WW98 - mandible (i-4)
73 39WW98 - cranium (i-2), r. lateral
74 39WW98 - cranium (i-2), l. lateral
75 39WW98 - cranium (i-2), superior
76 39WW98 - cranium (i-2), basal
77 39WW98 - cranium (i-2), frontal
78 39WW98 - cranium (i-2), occipital
79 39WW98 - hypermuscularity, l. femur (i-53)
80 39WW98 - hypermuscularity (close-up), l. femur (i-53)
81 38WW98 - cranium (j-1), r. lateral
82 38WW98 - cranium (j-1), l. lateral
83 38WW98 - cranium (j-1), basal
84 38WW98 - cranium (j-1), superior
85 39WW98 - cranium (j-1), frontal
86 38WW98 - cranium (j-1), occipital
87 38WW98 - cranium (j-1), (close-up) periosteal reaction
88 38WW98 - cranium (j-1), (close-up) periosteal reaction
89 pike haven recreation area - cranium (k-1), l. lateral
90 pike haven recreation area - cranium (k-1), r. lateral
91 pike haven recreation area - cranium (k-1), basal
92 pike haven recreation area - cranium (k-1), superior

93	pike haven recreation area - cranium (k-1), frontal
94	pike haven recreation area - cranium (k-1), occipital
95	brush creek area - cranium, l. lateral
96	brush creek area - cranium, superior
97	brush creek area - mandible
98	elm creek recreation area - periostitis, r. tibia (n-8)
99	39WW98 - cranium (o-6), r. lateral
100	39WW98 - cranium (o-6), l. lateral
101	39WW98 - cranium (o-6), superior
102	39WW98 - cranium (o-6), basal
103	39WW98 - cranium (o-6), frontal
104	39WW98 - cranium (o-6), occipital
105	okobojo point - mandible (p-50)
106	lecompte cemetery - r. innominate
107	lecompte cemetery - r. innominate, multiparity
108	prairie dog bay - severe weathering (see text page 65)
109	39LM59 - wedge shaped L2
110	39LM57 - mandible
111	39LM57 - maxilla
112	39LM256 - cranium (v-45), l. lateral
113	39LM256 - cranium (v-45), r. lateral
114	39LM256 - cranium (v-45), superior
115	39LM256 - cranium (v-45), basal
116	39LM256 - cranium (v-45), occipital
117	39LM256 - cranium (v-45), frontal
118	39LM256 - cranium (v-45), button osteoma
119	39LM256 - cranium (v-45), button osteoma
120	39LM256 - cranium (v-45), maxilla
121	39LM256 - cranium (v-68), temporo-mandibular joint, dislocation
122	39LM256 - healed colles fracture, r. radius
123	39LM256 - healed colles fracture, r. radius
124	39BR13 - cranium, superior
125	x-15 - cranium, superior
126	x-15 - cranium, l. lateral
127	x-15 - cranium, r. lateral
128	x-15 - cranium, basal
129	x-15 - cranium, frontal
130	x-15 - cranium, occipital
131	x-15 - cranium, bifurcated digastric groove
132	x-14 - cranium, superior
133	x-14 - cranium, r. lateral
134	x-14 - cranium, l. lateral
135	x-14 - cranium, occipital
136	x-14 - cranium, basal
137	x-14 - cranium, frontal
138	platte creek recreation area - cranium, r. lateral
139	platte creek recreation area - cranium, l. lateral
140	platte creek recreation area - cranium, superior
141	platte creek recreation area - cranium, basal
142	platte creek recreation area - cranium, occipital
143	platte creek recreation area - cranium, frontal

144 platte creek recreation area - cranium, caries

3. dental casts

catalogue no.	dentary
a-4/a-5	mandible and maxilla
c-1	maxilla
c-2	mandible and maxilla
d-1	maxilla
e-1	mandible and maxilla
f-1/f-2	mandible and maxilla
h-2/h-1	mandible and maxilla
i-1	maxilla
i-3	mandible
i-4	mandible
k-1	maxilla
p-50	mandible
v-42	maxilla
v-45	maxilla
aa-1	maxilla

APPENDIX D

Metric Descriptors of the
Cranial and Infracranial Skeleton

Key to metric sources

Bass 1971 - (B)
Brothwell 1981 - (BR)
Comas 1960 - (C)
Corruccini and Ciochon 1976 - (CC)
ElNajjar and McWilliams 1978 - (EM)
Farallay and Moore 1975 - (FM)
Feldesman 1976 - (F)
Howells 1973 - (H)
Hrdlicka 1939 - (HD)
Jantz and Willey 1983 - (JW)
Lavelle 1972 - (L)
Lisowski et al. 1974 - (LS)
McHenry 1975 - (MH)
McHenry 1978 - (MY)
McHenry and Corruccini 1975 - (MC)
McHenry and Corruccini 1978 - (MR)
McHenry et al. 1976 - (ML)
Rightmire 1970 - (R)
Sussman 1979 - (S)

a) cranial

frontal chord (H)
frontal arc (H)
maximum frontal breadth (H)
minimum frontal breadth (B)
simotic chord (H)
biorbital breadth (H)
interorbital breadth (H)
facial height (B)
nasal breadth (H)
nasal height (H)
upper facial height (B)
external palate breadth (B)
external palate length (B)
internal palate breadth (B)
internal palate length (B)
parietal chord (H)
parietal arc (H)
bizygomatic breadth (H)
biauricular breadth (H)
biasterionic breadth (H)
occipital chord (H)
occipital arc (H)
foramen magnum length (H)
foramen magnum breadth (BR)
bicondylar breadth (B)
bigonial breadth (B)
mandibular symphysis height (B)
foramen mentale breadth (BR)
mandibular corpus length (L)
cranial length (H)
cranial breadth (H)
basion-bregma height (H)
basion-porion height (B)
basion-nasion length (H)
basion-prosthion length (H)
auricular height (B)
cranial index (B)
cranial module (B)
length-height index (B)
breadth-height index (B)
mean-height index (B)
fronto-parietal index (B)
auricular mean-height index (JW)
orbit height (H)
orbit breadth (H)
malar length (H)
malar height (R)
mastoid height (H)
mastoid breadth (H)
tympanic plate thickness (EM)[1]
ramus height (B)
minimum ramus breadth (B)
coronoid height (L)
condyle height (L)
corpus height (L)

[1]transformed to metric descriptor

b) infracranial

clavicle

maximum length (B)
midshaft circumference (B)
sternal facet length (CC)

scapula

maximum length (B)
maximum breadth (B)
length of spine (B)
length supraspinous line (B)
length infraspinous line (B)
axillary border length (CC)
supraspinous fossa breadth (CC)
acromion breadth (CC)
coracoid length (CC)
glenoid fossa height (CC)

humerus

maximum length (CC)
maximum midshaft diameter (CC)
minimum midshaft diameter (CC)
maximum head diameter (CC)
a-p head diameter (CC)
intertubercular sulcus breadth (CC)
least circumference (CC)
trochlear breadth (MC)
a-p diameter of trochlea (MC)
capitulum breadth (MC)
capitulum height (MC)
olecranon fossa breadth (MC)

humerus (continued)
distal articular surface breadth (MC)
biepicondylar breadth (MC)
olecranon fossa medial wall breadth (MC)
olecranon fossa lateral wall breadth (MC)
medial epicondyle breadth (MC)
a-p shaft diameter (MC)

radius
maximum length (B)
a-p neck diameter (MY)
a-p head diameter (F)
distal breadth (F)
physiological length (EM)
m-l neck diameter (MY)
m-l head diameter (F)

ulna
maximum length (B)
least circumference (B)
a-p midshaft diameter (ML)
trochlear a-p diameter (ML)
olecranon a-p diameter (ML)
olecranon length (ML)
proximal m-l diameter (ML)
physiological length (B)
m-l midshaft diameter (ML)
trochlear m-l diameter (ML)
coronoid height (ML)
trochlear length (ML)
proximal a-p diameter (ML)
distal breadth (ML)

innominate
maximum height (MH)
acetabulum height (MH)
iliac height (MH)
maximum breadth (MH)
acetabulum transverse breadth (MH)
iliac blade minimum breadth (MH)

femur
maximum length (B)
a-p midshaft diameter (B)
head diameter (B)
subtrochanteric a-p diameter (B)
vertical neck diameter (MR)
proximal width (MR)
bicondylar breadth (MR)
a-p diameter lateral condyle (MR)
m-l diameter lateral condyle (MR)
condylar notch breadth (MR)
oblique length (B)
m-l midshaft diameter (B)
midshaft circumference (B)
subtrochanteric m-l diameter (B)
a-p neck diameter (MR)
neck length (MR)
a-p diameter distal shaft (MR)
a-p diameter medial condyle (MR)
m-l diameter medial condyle (MR)

patella
maximum length (HD)
maximum breadth (HD)

tibia
maximum length (B)
a-p diameter at nutrient foramen (B)
m-l diameter at nutrient foramen (B)
distal diameter (FM)
proximal a-p diameter (MY)
proximal m-l diameter (MY)

fibula
maximum length (B)

talus

maximum length (LS)

maximum trochlear height (LS)

transverse trochlear breadth (LS)

maximum breadth (LS)

calcaneus

maximum length (HD)

height (HD)

minimum breadth (HD)

Metacarpals, Metatarsals

length (S)

dorso-palmar midshaft diameter (S)

radio-ulnar midshaft diameter (S)

atlas

external breadth (C)

internal breadth (C)

external length (C)

internal length (C)

axis

external breadth (C)

external length (C)

C7

body breadth (C)

body length (C)

T12

body breadth (C)

body length (C)

L5

body breadth (C)

body length (C)

sternum

manubrium length (HD)

maximum body length (HD)

maximum body breadth (HD)

sacrum

maximum height (HD)

maximum breadth (HD)

Table D1. Unpaired cranial metric dimensions.

descriptor	a-4/5	c-2	c-1	d-1	e-1	f-1/2	h-2/1	i-1/4	i-2/3	i-5
frontal chord	112.1	103.1	115.3	110.1	115.1	104.8	- -	110.3	118.2	103.5
frontal arc	125.0	113.5	131.2	122.3	130.0	118.7	- -	125.7	122.1	120.2
max frontal br	106.8	106.7	113.8	111.2	123.9	109.9	115.1	117.1	107.3	- -
min frontal br	91.0	89.5	98.9	85.2	95.9	82.2	97.0	92.1	89.0	- -
simotic chord	9.7	7.9	9.1	9.8	10.0	8.3	- -	7.4	- -	- -
biorbital br	97.4	89.2	100.2	93.5	101.1	85.0	- -	98.9	- -	- -
interorbital br	24.9	26.2	27.6	23.0	26.9	18.1	- -	22.5	- -	- -
facial ht	105.3	104.5	- -	- -	126.1	- -	- -	[illegible]	- -	- -
nasal br	23.5	27.9	28.5	25.8	26.5	22.0	- -	25.0	- -	- -
nasal ht	45.2	45.8	53.3	51.2	51.6	41.2	- -	50.2	- -	- -
upper facial ht	66.2	64.5	72.8	75.0	77.6	54.2	- -	67.9	- -	- -
ext palate br	60.8	67.2	65.9	60.8	- -	59.9	- -	62.9	- -	- -
ext palate ln	49.3	53.7	51.4	53.5	56.0	40.2	- -	57.3	- -	- -
int palate br	34.2	42.3	42.4	42.7	40.6	34.3	- -	39.2	- -	- -
int palate ln	34.9	47.2	46.1	40.8	45.0	33.0	- -	40.1	- -	- -
parietal chord	110.2	104.2	120.7	117.8	114.0	96.5	116.9	117.9	112.9	119.2
parietal arc	122.0	119.4	140.6	136.8	132.0	117.2	130.5	130.8	129.7	132.4
bizygomatic br	129.0	127.2	- -	134.6	145.9	113.4	- -	134.8	- -	- -
biauricular br	114.9	113.3	127.1	120.1	134.0	106.1	130.2	117.8	129.2	- -
biasterionic br	107.3	104.2	110.0	110.0	119.9	103.1	110.4	111.1	116.2	- -
occipital chord	96.1	82.0	- -	- -	101.7	97.1	99.2	96.0	93.0	88.9
occipital arc	117.3	101.1	- -	- -	127.5	117.2	127.4	122.3	120.8	112.0
foramen magnum ln	37.0	29.8	- -	- -	37.3	33.0	- -	39.2	39.8	- -
foramen magnum br	27.4	30.6	- -	28.2	29.3	26.8	- -	29.1	32.1	- -
bicondylar br	116.2	- -	- -	- -	120.5	- -	129.7	118.5	- -	- -
bigonial br	95.1	- -	- -	- -	102.3	- -	107.8	98.2	102.9	- -
mand symphysis ht	30.9	29.3	- -	- -	38.7	- -	37.1	33.7	29.1	- -
foramen mentale br	48.1	44.0	- -	- -	53.6	- -	51.6	45.4	43.8	- -
mand corpus ln	99.7	- -	- -	- -	104.0	- -	107.3	103.8	116.5	- -
cranial ln	180.1	159.6	184.3	176.9	183.2	157.5	- -	185.0	194.2	176.3

Table D1. Continued.

descriptor	a-4/5	c-2	c-1	d-1	e-1	f-1/2	h-2/1	i-1/4	i-2/3	i-5
cranial br	125.1	135.8	139.4	133.8	142.5	132.8	- -	135.8	138.9	- -
basion-bregma ht	130.0	120.2	- -	141.0	137.8	118.2	- -	130.9	126.2	- -
basion-porion ht	17.9	13.2	- -	25.8	21.3	13.8	- -	17.0	16.9	- -
basion-nasion ln	97.0	- -	92.9	98.0	102.5	83.1	- -	101.2	109.0	- -
basion-prosth ln	97.0	98.2	- -	89.2	102.1	79.4	- -	101.3	- -	- -
auricular height	111.6	109.8	118.1	117.7	118.2	106.7	- -	114.0	112.1	- -
cranial index	69.5	85.1	75.6	75.6	77.6	84.3	- -	73.4	71.5	- -
cranial module	145.1	138.5	- -	150.6	154.7	136.2	- -	150.6	153.1	- -
ln-ht index	72.2	75.3	- -	79.7	75.0	75.0	- -	70.8	65.0	- -
br-ht index	103.9	88.5	- -	105.4	96.7	89.0	- -	96.4	90.9	- -
mean-height index	85.2	81.4	- -	90.8	84.5	81.4	- -	81.6	75.8	- -
fronto-pariet index	72.7	65.9	70.9	63.7	67.3	61.9	- -	67.8	64.1	- -
auric mean-ht index	73.1	74.3	72.9	75.7	72.6	73.5	- -	71.1	67.3	- -

Table D1. Continued.

descriptor	j-1/2	k-1	l-1	m-1/2	o-6	p-50	t-8/5	v-45	v-44	v-42
frontal chord	--	115.8	--	109.1	101.8	--	--	116.8	--	--
frontal arc	--	131.0	--	117.5	113.5	--	--	130.0	--	--
max frontal br	106.2	117.1	--	117.9	108.7	--	--	113.7	--	--
min frontal br	--	96.9	--	90.0	86.8	--	--	88.3	--	--
simotic chord	--	9.2	--	--	7.9	--	--	--	--	12.0
biorbital br	--	100.1	--	--	87.7	--	--	--	--	--
interorbital br	--	23.3	--	--	20.7	--	--	--	--	25.1
facial ht	--	--	--	--	--	--	--	--	--	--
nasal br	--	26.8	--	--	23.9	--	--	--	--	--
nasal ht	--	51.2	--	--	--	--	--	--	--	50.3
upper facial ht	--	67.0	--	--	--	--	--	--	--	--
ext palate br	--	65.3	--	--	--	--	58.3	56.2	--	--
ext palate ln	--	48.1	--	--	--	--	50.2	49.8	--	--
int palate br	--	40.8	--	--	--	--	39.8	36.1	--	--
int palate ln	--	49.7	--	--	--	--	39.5	42.9	--	--
parietal chord	118.4	111.4	100.2	100.8	110.0	--	--	109.2	105.9	--
parietal arc	122.7	124.0	122.3	110.2	126.3	--	--	120.1	116.8	--
bizygomatic br	--	--	--	--	--	--	--	--	--	--
biauricular br	112.5	125.0	--	--	--	--	--	--	--	--
biasterionic br	107.1	106.9	--	--	--	--	--	--	--	--
occipital chord	92.1	94.2	88.3	--	--	--	--	93.0	--	--
occipital arc	111.1	114.1	100.0	--	--	--	--	119.5	--	--
foramen magnum ln	35.0	36.8	--	--	--	--	--	38.1	--	35.3
foramen magnum br	29.8	29.8	--	--	--	--	--	31.2	--	30.2
bicondylar br	--	--	--	--	--	--	--	--	--	--
bigonial br	--	--	--	98.0	--	90.2	--	--	--	--
mand symphysis ht	--	--	--	21.7	--	21.2	--	--	--	32.3
foramen mentale br	--	--	--	41.1	--	38.6	--	--	--	44.1
mand corpus ln	--	--	--	99.0	--	--	--	--	--	--
cranial ln	167.1	178.1	--	172.2	172.7	--	--	189.1	181.1	--

Table D1. Continued.

descriptor	j-1/2	k-1	l-1	m-1/2	o-6	p-50	t-8/5	v-45	v-44	v-42
cranial br	132.0	142.9	--	--	131.2	--	--	137.3	--	--
basion-bregma ht	117.1	115.3	--	--	--	--	--	175.2	--	--
basion-porion ht	15.9	21.9	--	--	--	--	--	--	--	--
basion-nasion ln	--	104.1	--	--	--	--	--	100.5	--	--
basion-prosth ln	--	82.8	--	--	--	--	--	--	--	--
auricular height	108.1	111.1	--	--	--	--	--	--	--	--
cranial index	79.0	80.2	--	--	76.0	--	--	72.6	--	--
cranial module	138.7	145.4	--	--	--	--	--	150.5	--	--
ln-ht index	70.1	64.7	--	--	--	--	--	66.2	--	--
br-ht index	88.7	80.7	--	--	--	--	--	91.2	--	--
mean-height index	78.3	71.8	--	--	--	--	--	76.7	--	--
fronto-pariet index	--	67.8	--	--	66.2	--	--	64.3	--	--
auric mean-ht index	72.2	69.0	--	--	--	--	--	--	--	--

Table D1. Continued.

descriptor	v-68	v-48	x-3	x-14	x-15	y-3	z-1	aa-1
frontal chord	101.0	--	--	111.9	110.8	--	110.8	109.2
frontal arc	118.8	--	--	129.8	127.6	--	122.8	126.9
max frontal br	101.2	--	112.1	121.2	113.2	--	113.4	115.6
min frontal br	84.9	--	--	92.8	94.9	--	91.3	94.9
simotic chord	--	--	--	--	8.4	--	7.9	12.0
biorbital br	--	--	--	--	--	--	--	--
interorbital br	--	--	--	--	25.8	--	24.1	24.2
facial ht	--	--	--	--	--	--	--	--
nasal br	--	--	--	--	--	--	27.1	23.9
nasal ht	--	--	--	--	--	--	56.4	52.3
upper facial ht	--	--	--	--	--	--	--	69.2
ext palate br	--	--	--	--	--	--	--	60.4
ext palate ln	--	--	--	--	--	--	52.8	52.8
int palate br	--	--	--	--	--	--	--	35.9
int palate ln	--	--	--	--	--	--	46.8	45.6
parietal chord	--	--	--	95.1	104.8	--	103.0	105.4
parietal arc	--	--	--	106.8	117.2	--	121.6	118.1
bizygomatic br	--	--	--	--	--	--	--	--
biauricular br	--	--	--	126.9	128.0	--	--	110.3
biasterionic br	--	--	--	117.1	111.2	--	--	--
occipital chord	--	--	--	108.1	--	--	--	93.8
occipital arc	--	--	--	138.2	--	--	--	115.0
foramen magnum ln	--	--	--	36.9	--	--	--	32.5
foramen magnum br	--	--	--	30.9	--	--	--	26.2
bicondylar br	--	--	--	--	--	--	--	--
bigonial br	--	--	--	--	--	--	--	--
mand symphysis ht	--	24.3	--	--	--	33.7	--	--
foramen mentale br	--	45.7	--	--	--	46.4	--	--
mand corpus ln	--	--	--	--	--	--	--	--
cranial ln	--	--	--	182.1	184.0	--	--	175.6

Table D1. Continued.

descriptor	v-68	v-48	x-3	x-14	x-15	y-3	z-1	aa-1
cranial br	- -	- -	- -	145.2	141.8	- -	- -	134.1
basion-bregma ht	- -	- -	- -	129.0	- -	- -	- -	127.0
basion-porion ht	- -	- -	- -	14.0	- -	- -	- -	18.0
basion-nasion ln	- -	- -	- -	- -	- -	- -	- -	97.9
basion-prosth ln	- -	- -	- -	- -	- -	- -	- -	94.9
auricular height	- -	- -	- -	116.0	110.0	- -	- -	108.1
cranial index	- -	- -	- -	79.7	77.1	- -	- -	76.4
cranial module	- -	- -	- -	152.1	- -	- -	- -	145.6
ln-ht index	- -	- -	- -	70.8	- -	- -	- -	72.3
br-ht index	- -	- -	- -	88.8	- -	- -	- -	94.7
mean-height index	- -	- -	- -	78.8	- -	- -	- -	82.0
fronto-pariet index	- -	- -	- -	63.9	66.9	- -	- -	70.8
auric mean-ht index	- -	- -	- -	70.9	67.5	- -	- -	69.8

Table D2. Paired cranial metric dimensions.

descriptor	a-4/5 l	a-4/5 r	c-1 l	c-1 r	c-2 l	c-2 r	d-1 l	d-1 r	e-1 l	e-1 r	f-1/2 l	f-1/2 r
orbit ht	34.5	33.1	32.2	34.1	32.0	31.6	32.1	30.9	33.9	34.2	32.9	32.0
orbit br	38.6	37.1	38.1	38.2	37.2	36.1	37.2	35.6	38.4	37.7	33.1	33.7
malar ln	54.2	55.3	45.0	44.7	55.3	47.3	56.1	53.8	60.7	59.4	44.3	45.7
malar ht	22.9	22.3	22.1	22.3	26.2	27.0	24.5	24.9	29.2	30.9	19.9	19.8
mastoid ht	25.7	25.3	20.9	26.3	21.9	20.1	26.7	25.4	28.4	27.2	15.0	17.4
mastoid br	19.8	19.2	22.8	22.2	15.4	15.9	21.3	18.1	22.4	22.3	16.7	15.3
tymp plate thck	4.2	6.0	5.8	5.0	4.9	4.2	6.1	6.9	6.7	5.9	6.3	6.7
ramus ht	57.9	56.1	- -	57.2	- -	- -	- -	- -	76.0	76.1	53.2	- -
min ramus br	33.7	35.1	- -	31.2	- -	- -	- -	- -	40.1	37.1	32.9	- -
coronoid ht	56.4	55.2	- -	67.1	- -	- -	- -	- -	81.2	78.3	52.0	- -
condyle ht	57.8	54.3	- -	56.3	- -	- -	- -	- -	75.2	76.9	53.8	- -
corpus ht	26.1	25.6	- -	33.6	- -	- -	- -	- -	37.5	36.4	25.7	- -

Table D2. Continued.

descriptor	h-2/1		i-1		i-2/3		i-5		j-1/2		k-1	
	l	r	l	r	l	r	l	r	l	r	l	r
orbit ht	--	--	31.6	31.1	--	--	--	--	--	--	35.8	37.1
orbit br	--	--	37.1	39.2	--	--	--	--	--	--	40.0	40.1
malar ln	--	--	51.7	52.6	--	--	--	--	--	--	--	--
malar ht	26.2	--	18.8	18.5	24.1	--	--	--	--	--	--	21.9
mastoid ht	23.8	27.8	23.7	25.8	36.9	29.5	15.3	--	25.0	22.1	--	22.2
mastoid br	20.4	22.0	16.9	19.1	25.0	20.0	14.9	--	18.0	15.2	--	23.5
tymp plate thck	7.0	6.9	5.3	4.7	4.2	4.1	4.1	4.8	6.0	4.7	6.8	2.4
ramus ht	65.7	69.8	54.2	54.6	--	70.5	--	--	48.0	--	--	--
min ramus br	40.0	39.9	31.3	29.2	39.8	40.2	--	--	27.0	--	--	--
coronoid ht	71.4	68.0	57.8	60.3	--	--	--	--	51.2	--	--	--
condyle ht	65.3	67.7	49.3	48.2	--	62.3	--	--	42.5	--	--	--
corpus ht	31.2	32.0	22.3	23.6	21.2	26.7	--	--	20.8	--	--	--

Table D2. Continued.

descriptor	m-1/2 l	m-1/2 r	o-6 l	o-6 r	p-50 l	p-50 r	t-8 l	t-8 r	t-5 l	t-5 r	t-6 l	t-6 r
orbit ht	--	--	33.0	32.2	--	--	--	--	--	--	--	--
orbit br	--	--	37.8	36.4	--	--	--	--	--	--	--	--
malar ln	--	--	--	46.8	--	--	--	--	--	--	--	--
malar ht	--	--	--	20.9	--	--	--	27.8	--	--	--	--
mastoid ht	26.0	25.0	--	22.7	--	18.3	--	--	--	--	--	--
mastoid br	22.9	19.7	--	21.0	--	13.9	--	--	--	--	--	--
tymp plate thck	7.0	7.9	--	5.3	--	5.0	--	--	--	--	--	--
ramus ht	--	--	--	59.2	--	46.0	--	--	58.2	--	56.8	--
min ramus br	31.7	32.4	--	31.3	26.9	27.7	--	--	34.8	--	--	--
coronoid ht	--	--	--	--	--	--	--	--	65.0	--	--	--
condyle ht	60.2	56.2	--	--	--	41.8	--	--	53.0	--	--	--
corpus ht	--	--	--	--	19.0	18.9	--	--	21.9	--	--	--

Table D2. Continued.

descriptor	v-45		v-44		v-42		v-68		v-48		w-43	
	l	r	l	r	l	r	l	r	l	r	l	r
orbit ht	--	--	--	--	34.9	--	--	--	--	--	--	--
orbit br	--	--	--	--	40.3	--	--	--	--	--	--	--
malar ln	--	--	--	--	54.2	52.5	--	--	--	--	--	--
malar ht	--	--	23.7	--	23.7	23.4	--	--	--	--	--	--
mastoid ht	33.1	35.7	24.0	26.2	24.0	18.2	18.9	17.2	--	--	--	--
mastoid br	30.6	28.3	21.5	23.2	17.8	17.0	13.3	12.0	--	--	--	--
tymp plate thck	2.3	2.2	7.8	7.3	5.4	6.1	6.0	7.2	--	--	--	--
ramus ht	--	--	--	--	62.8	--	--	--	--	66.7	--	--
min ramus br	--	--	--	--	32.1	--	--	--	--	33.0	32.1	29.8
coronoid ht	--	--	--	--	--	--	--	--	--	66.5	--	--
condyle ht	--	--	--	--	56.7	--	--	--	--	61.9	--	--
corpus ht	--	--	--	--	30.1	28.1	--	--	--	27.1	28.1	--

Table D2. Continued.

descriptor	x-14		x-15		y-3		z-1		aa-1	
	l	r	l	r	l	r	l	r	l	r
orbit ht	--	--	--	32.9	--	--	--	34.8	34.2	30.9
orbit br	--	--	--	42.1	--	--	--	37.6	--	40.1
malar ln	53.4	--	--	55.0	--	--	--	56.3	--	53.0
malar ht	23.9	--	--	30.2	--	--	--	27.9	--	26.2
mastoid ht	29.5	25.2	--	31.0	--	--	--	--	--	25.1
mastoid br	20.2	21.8	24.2	24.3	--	--	--	--	--	19.9
tymp plate thck	5.9	5.9	5.9	6.8	--	--	--	--	6.8	8.2
ramus ht	--	--	--	--	--	--	--	--	--	--
min ramus br	--	--	--	--	--	37.4	--	--	--	--
coronoid ht	--	--	--	--	--	--	--	--	--	--
condyle ht	--	--	--	--	--	--	--	--	--	--
corpus ht	--	--	--	--	25.8	26.6	--	--	--	--

Table D3. Paired infracranial metric dimensions: clavicle and scapula.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
clavicle	a-50	a-51		b-9	b-59			d-6	g-50		h-40	h-39
maximum length	132.1	130.0	--	147.2	--	--	--	148.9	--	--	--	--
midshaft circumfer	27.5	28.0	--	32.3	32.5	--	--	34.0	32.0	--	38.3	36.4
sternal facet ln	23.1	22.3	--	28.9	--	--	--	26.6	27.0	--	--	--
scapula	a-16	a-17	b-10						g-11	g-12	h-42	h-41
maximum length	138.0	--	--	--	--	--	--	--	144.9	141.2	--	--
maximum breadth	89.2	--	--	--	--	--	--	--	102.8	102.1	--	--
length of spine	116.6	--	--	--	--	--	--	--	134.8	133.4	--	--
ln supraspinous line	--	--	--	--	--	--	--	--	38.9	40.8	--	--
ln infraspinous line	--	--	--	--	--	--	--	--	112.1	110.2	--	--
axillary border ln	--	--	--	--	--	--	--	--	138.1	138.8	--	--
supraspinous fossa br	--	--	--	--	--	--	--	--	38.4	40.6	--	--
acromion breadth	22.2	--	--	--	--	--	--	--	42.8	38.8	--	--
coracoid length	37.9	36.8	--	--	--	--	--	--	--	38.9	--	--
glenoid fossa height	26.2	25.3	--	--	--	--	--	--	32.1	33.2	--	--

Table D3. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
clavicle	i-152	i-153								m-29	s-9	s-75
maximum length	--	--	--	--	--	--	--	--	--	--	148.1	--
midshaft circumfer	28.2	30.8	--	--	--	--	--	--	--	32.8	32.3	29.0
sternal facet ln	--	--	--	--	--	--	--	--	--	--	25.8	27.6
scapula	i-9	i-10	i-11	i-13	i-12	i-14		i-15			s-81	
maximum length	--	--	--	131.9	--	--	--	--	--	--	--	--
maximum breadth	--	--	--	--	--	107.8	--	--	--	--	--	--
length of spine	122.9	--	--	127.2	--	--	--	--	--	--	--	--
ln supraspinous line	--	--	46.0	45.6	--	--	--	--	--	--	--	--
ln infraspinous line	115.1	--	--	98.6	--	--	--	--	--	--	--	--
axillary border ln	125.1	--	--	117.2	--	--	--	--	--	--	--	--
supraspinous fossa br	--	48.1	37.3	33.8	--	--	--	--	--	--	--	--
acromion breadth	47.8	44.1	--	40.2	--	--	--	--	--	--	--	--
coracoid length	35.2	--	--	--	--	45.5	--	40.4	--	--	--	--
glenoid fossa height	33.7	33.9	--	--	40.2	40.9	--	--	--	--	36.9	--

Table D3. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
clavicle					w-32	w-33			y-9			
maximum length	--	--	--	--	--	--	--	--	--	--		
midshaft circumfer	--	--	--	--	32.2	30.8	--	--	--	--		
sternal facet ln	--	--	--	--	--	--	--	--	--	--		
scapula	v-57		v-58		w-9		x-4			y-10		
maximum length	157.0	--	--	--	--	--	--	--	--	--		
maximum breadth	99.1	--	--	--	--	--	--	--	--	--		
length of spine	130.2	--	--	--	--	--	--	--	--	--		
ln supraspinous line	53.4	--	--	--	--	--	--	--	--	--		
ln infraspinous line	124.8	--	--	--	--	--	--	--	--	--		
axillary border ln	133.0	--	--	--	--	--	124.9	--	--	--		
supraspinous fossa br	47.0	--	--	--	--	--	--	--	--	--		
acromion breadth	41.1	--	--	--	--	--	--	--	--	--		
coracoid length	37.1	--	--	--	--	--	--	--	--	--		
glenoid fossa height	34.1	--	37.1	--	--	--	--	--	--	--		

Table D4. Paired infracranial metric dimensions: humerus.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
	a-8	a-1	b-6	b-4	b-51		d-10	d-9	e-21		g-4	g-6
maximum length	290.0	293.0	- -	310.5	- -	- -	317.3	324.8	301.0	- -	325.2	331.4
max midshaft diam	20.4	20.1	21.2	21.7	- -	- -	20.1	22.1	23.2	- -	20.8	20.9
min midshaft diam	14.0	14.2	15.2	16.0	- -	- -	14.3	14.9	15.4	- -	14.9	15.2
max head diameter	39.5	40.0	- -	45.3	- -	- -	40.2	40.4	39.9	- -	40.1	40.8
a-p head diameter	42.5	38.1	- -	42.8	- -	- -	44.0	45.9	42.1	- -	41.8	41.7
intertuber sulcus br	7.7	6.2	- -	9.1	- -	- -	5.2	7.3	7.2	- -	6.1	6.1
least circumference	53.5	52.8	57.6	57.2	- -	- -	54.7	58.8	63.0	- -	57.8	59.0
trochlear breadth	16.1	18.8	- -	22.3	- -	- -	20.5	22.1	21.8	- -	20.1	20.0
a-p diam of trochlea	16.2	16.2	- -	16.0	- -	- -	26.3	27.9	25.2	- -	24.9	25.1
capitulum breadth	15.3	17.9	- -	18.3	- -	- -	16.8	17.1	15.8	- -	15.2	17.0
capitulum height	17.9	18.9	- -	20.2	- -	- -	19.9	21.4	19.8	- -	19.4	19.1
distal art surf br	41.2	40.0	- -	43.3	- -	- -	41.6	42.9	39.2	- -	39.9	38.9
biepicondylar br	56.0	53.7	- -	60.0	- -	- -	58.8	59.2	57.9	- -	56.8	57.3
olecranon fossa br	23.1	25.3	- -	27.1	- -	- -	24.8	26.0	26.2	- -	28.8	28.4
olec fos med wall br	6.9	6.1	- -	15.2	- -	- -	9.9	9.8	10.4	- -	7.9	8.3
olec fos lat wall br	14.7	14.3	- -	18.8	- -	- -	16.4	17.3	17.9	- -	14.9	14.8
medial epicondyle br	11.9	11.2	- -	14.2	- -	- -	12.9	14.1	13.3	- -	12.2	12.6
a-p shaft diameter	13.9	13.9	- -	16.1	- -	- -	15.2	16.1	16.7	- -	15.4	15.1

Table D4. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
		h-9	i-48	i-42	i-21	i-44	i-45	i-42	m-7	m-12		n-6
maximum length	--	--	302.1	307.0	--	--	325.3	307.0	--	299.9	--	323.0
max midshaft diam	--	22.1	19.7	21.4	20.3	--	22.6	21.4	20.1	19.5	--	--
min midshaft diam	--	16.7	12.8	16.6	15.7	--	15.9	16.6	14.1	14.6	--	--
max head diameter	--	--	40.2	41.7	--	--	45.1	41.7	--	37.4	--	44.0
a-p head diameter	--	--	37.6	38.2	--	--	48.7	38.2	--	42.3	--	47.0
intertuber sulcus br	--	--	8.2	10.1	--	--	7.8	10.1	--	7.0	--	5.1
least circumference	--	61.7	50.9	55.3	--	52.0	63.8	55.3	55.4	55.3	--	--
trochlear breadth	--	28.5	21.1	23.3	--	19.0	20.1	23.3	18.8	19.1	--	19.3
a-p diam of trochlea	--	18.3	23.9	26.8	--	25.0	28.0	26.8	--	--	--	27.8
capitulum breadth	--	18.0	16.5	15.9	16.2	16.1	--	15.9	15.9	16.1	--	19.1
capitulum height	--	18.0	19.1	19.3	19.1	18.0	21.2	19.3	--	19.1	--	21.4
distal art surf br	--	42.7	38.2	39.7	--	37.0	--	39.7	40.1	40.2	--	43.9
biepicondylar br	--	62.2	57.2	--	--	55.4	--	--	56.3	57.1	--	61.9
olecranon fossa br	--	29.1	26.3	24.9	--	27.9	28.2	24.9	20.3	20.8	--	26.8
olec fos med wall br	--	9.6	13.8	--	--	7.7	8.5	--	10.6	9.9	--	8.8
olec fos lat wall br	--	18.3	16.3	16.5	17.2	13.3	17.0	16.5	16.2	16.4	--	17.2
medial epicondyle br	--	13.8	13.3	--	--	12.0	--	--	12.9	12.6	--	14.9
a-p shaft diameter	--	--	19.2	20.8	--	13.8	16.7	20.8	14.3	13.2	--	16.1

Table D4. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
	v-12	v-14	v-21		w-29	w-24	y-8	y-5				
maximum length	--	--	--	--	--	293.4	--	--				
max midshaft diam	--	--	--	--	20.4	21.1	--	--				
min midshaft diam	--	--	--	--	14.9	14.1	--	--				
max head diameter	--	--	40.1	--	--	--	--	--				
a-p head diameter	--	--	44.0	--	--	--	--	--				
intertuber sulcus br	--	--	8.8	--	--	6.2	--	--				
least circumference	58.0	--	--	--	56.0	57.2	--	--				
trochlear breadth	20.2	--	--	--	--	--	--	--				
a-p diam of trochlea	27.1	26.2	--	--	--	--	--	--				
capitulum breadth	16.1	--	--	--	--	14.9	--	15.6				
capitulum height	19.1	--	--	--	--	18.2	--	27.8				
distal art surf br	39.7	--	--	--	--	--	--	--				
biepicondylar br	54.9	--	--	--	--	51.3	--	--				
olecranon fossa br	27.0	26.5	--	--	--	21.1	--	27.1				
olec fos med wall br	6.7	6.1	--	--	7.9	7.9	--	7.4				
olec fos lat wall br	14.2	15.3	--	--	15.3	15.0	--	17.9				
medial epicondyle br	13.0	12.9	--	--	--	10.6	--	--				
a-p shaft diameter	15.6	15.8	--	--	15.0	15.2	--	17.3				

Table D5. Paired infracranial metric dimensions: radius, ulna and innominate.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
radius	a-10	a-11	b-7	b-5	b-53		d-13	d-12	e-20			g-7
maximum length	213.9	215.0	- -	244.6	- -	- -	255.2	255.4	253.1	- -	- -	253.9
physiological length	208.2	207.9	- -	237.5	- -	- -	248.6	248.8	245.4	- -	- -	247.1
a-p neck diameter	15.0	12.2	- -	11.6	- -	- -	12.5	12.6	10.6	- -	- -	11.0
m-l neck diameter	12.9	13.1	- -	11.7	- -	- -	11.9	12.0	12.8	- -	- -	9.7
a-p head diameter	- -	20.6	- -	21.8	- -	- -	21.9	21.8	20.0	- -	- -	21.4
m-l head diameter	- -	20.3	- -	21.2	- -	- -	20.2	21.9	20.4	- -	- -	20.7
distal breadth	27.5	28.4	31.1	31.8	27.4	- -	32.1	32.3	31.7	- -	- -	30.8
ulna	a-12	a-13	b-1	b-8			d-8	d-14	e-22			g-8
maximum length	236.0	- -	- -	266.0	- -	- -	275.9	278.2	271.1	- -	- -	270.7
physiological length	202.4	- -	- -	236.5	- -	- -	246.8	245.0	238.6	- -	- -	241.9
least circumference	31.5	- -	33.4	36.0	- -	- -	34.6	37.8	35.5	- -	- -	35.4
m-l midshaft diameter	12.7	11.4	13.5	12.8	- -	- -	12.3	14.0	15.2	- -	- -	15.8
a-p midshaft diameter	13.3	11.9	14.8	15.0	- -	- -	11.4	12.8	18.6	- -	- -	12.5
trochlear m-l diameter	18.2	18.0	- -	16.2	- -	- -	17.3	18.2	18.2	- -	- -	16.6
trochlear a-p diameter	17.6	17.4	- -	18.7	- -	- -	19.4	19.1	18.1	- -	- -	16.9
coronoid height	32.1	33.2	- -	34.7	- -	- -	34.0	33.2	33.6	- -	- -	31.2
olecranon a-p diameter	22.9	21.9	- -	22.6	- -	- -	26.9	26.1	26.2	- -	- -	22.0
trochlear length	22.2	21.8	- -	22.1	- -	- -	22.3	22.1	24.2	- -	- -	21.1
olecranon length	18.8	18.4	- -	22.3	- -	- -	22.1	22.4	19.9	- -	- -	19.8
proximal a-p diameter	17.0	16.2	16.7	17.1	- -	- -	16.7	16.2	18.4	- -	- -	15.8
proximal m-l diameter	11.1	11.0	15.5	15.8	- -	- -	11.7	13.0	13.0	- -	- -	13.5
distal breadth	14.9	- -	18.9	21.1	- -	- -	18.2	19.2	16.7	- -	- -	17.0
innominate	a-18	a-19		b-16	b-70		d-2		e-4	e-3	g-14	g-13
maximum height	- -	187.1	- -	- -	- -	- -	213.8	- -	219.0	220.3	222.9	- -
maximum breadth	142.0	141.7	- -	148.9	- -	- -	152.7	- -	164.8	164.7	- -	166.1
acetabulum height	- -	52.1	- -	51.9	- -	- -	53.2	- -	56.2	57.3	61.1	59.9
acetabulum transv br	- -	- -	- -	- -	- -	- -	50.1	- -	49.1	51.1	50.1	50.8
iliac height	- -	128.9	- -	122.9	- -	- -	132.9	- -	144.0	138.0	139.2	136.0
iliac blade min br	61.1	61.7	- -	72.7	- -	- -	54.8	- -	59.4	57.9	59.2	64.6

Table D5. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
radius		h-11	i-54	i-35		i-38			m-13	m-8		
maximum length	--	--	261.0	--	--	261.9	--	--	226.6	230.2	--	--
physiological length	--	--	255.3	--	--	255.5	--	--	220.7	224.4	--	--
a-p neck diameter	--	12.9	13.8	12.0	--	13.2	--	--	10.8	10.7	--	--
m-l neck diameter	--	11.8	15.0	10.9	--	11.4	--	--	9.9	9.7	--	--
a-p head diameter	--	24.0	24.5	21.0	--	23.1	--	--	--	--	--	--
m-l head diameter	--	25.1	23.1	20.6	--	23.3	--	--	19.2	20.2	--	--
distal breadth	--	--	34.8	--	--	35.4	--	--	29.9	31.2	--	--
ulna		h-10	i-33	i-40	i-37	i-41	i-34		m-4	m-14		
maximum length	--	--	--	--	--	--	--	--	--	248.2	--	--
physiological length	--	--	--	--	--	--	--	--	--	220.2	--	--
least circumference	--	31.8	--	--	--	--	--	--	--	39.2	--	--
m-l midshaft diameter	--	16.2	--	16.5	12.7	12.7	15.1	--	--	14.5	--	--
a-p midshaft diameter	--	13.6	--	15.2	12.6	13.0	14.9	--	--	12.2	--	--
trochlear m-l diameter	--	--	18.0	20.2	--	15.1	--	--	17.2	18.0	--	--
trochlear a-p diameter	--	--	--	19.5	--	17.9	--	--	17.2	18.3	--	--
coronoid height	--	--	31.7	37.1	--	32.3	--	--	34.0	33.1	--	--
olecranon a-p diameter	--	--	--	27.2	--	22.7	--	--	23.9	24.6	--	--
trochlear length	--	--	--	22.7	--	19.8	--	--	20.1	19.9	--	--
olecranon length	--	--	--	21.1	--	29.0	--	--	18.2	18.3	--	--
proximal a-p diameter	--	--	15.3	17.0	15.2	15.8	17.7	--	14.9	17.0	--	--
proximal m-l diameter	--	--	12.2	15.7	11.4	11.3	14.3	--	10.7	11.3	--	--
distal breadth	--	--	--	--	--	--	--	--	--	19.2	--	--
innominate	h-38	h-37	i-16	i-7	i-17	i-18	i-19	i-20		m-16	q-2	q-1
maximum height	--	--	--	200.7	--	--	--	--	--	--	--	194.6
maximum breadth	--	166.9	--	158.0	156.0	--	--	--	--	--	--	154.4
acetabulum height	--	--	56.1	49.3	48.2	--	49.1	--	--	--	--	55.1
acetabulum transv br	--	--	--	43.8	44.8	--	48.1	--	--	--	--	48.2
iliac height	--	--	127.1	120.8	122.8	--	123.8	--	--	--	--	123.9
iliac blade min br	60.7	64.8	63.8	53.0	53.8	--	53.0	--	--	57.1	--	57.9

Table D5. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
radius			s-74				v-17	v-15		v-16	w-30	w-25
maximum length	--	--	--	--	--	--	--	--	--	243.0	--	--
physiological length	--	--	--	--	--	--	241.2	--	--	235.2	--	--
a-p neck diameter	--	--	13.0	--	--	--	11.5	12.0	--	11.2	11.1	10.9
m-l neck diameter	--	--	9.0	--	--	--	10.8	10.9	--	10.8	10.9	11.0
a-p head diameter	--	--	21.5	--	--	--	21.5	21.6	--	21.9	--	--
m-l head diameter	--	--	20.9	--	--	--	20.7	21.8	--	20.6	--	--
distal breadth	--	--	--	--	--	--	--	--	--	33.3	--	--
ulna	s-2					u-4	v-13	v-23	v-24		w-27	w-26
maximum length	--	--	--	--	--	--	--	--	--	--	--	--
physiological length	--	--	--	--	--	--	--	--	--	--	--	--
least circumference	--	--	--	--	--	--	--	33.0	37.0	--	--	--
m-l midshaft diameter	--	--	--	--	--	--	14.5	--	--	--	13.1	13.6
a-p midshaft diameter	--	--	--	--	--	--	15.0	--	--	--	12.6	13.2
trochlear m-l diameter	18.9	--	--	--	--	--	16.0	--	--	--	--	15.2
trochlear a-p diameter	18.0	--	--	--	--	--	19.0	--	--	--	--	17.0
coronoid height	33.8	--	--	--	--	--	32.9	--	--	--	--	32.2
olecranon a-p diameter	20.2	--	--	--	--	--	23.4	--	--	--	--	21.1
trochlear length	22.3	--	--	--	--	--	20.3	--	--	--	--	19.9
olecranon length	18.0	--	--	--	--	--	19.8	--	--	--	--	20.5
proximal a-p diameter	18.0	--	--	--	--	--	14.9	--	--	--	17.0	16.9
proximal m-l diameter	15.0	--	--	--	--	--	12.3	--	--	--	11.2	11.1
distal breadth	--	--	--	--	--	--	--	20.2	--	--	--	--
innominate	s-47	s-1	s-3	s-17			v-59	v-60			w-6	
maximum height	193.9	191.5	185.5	--	--	--	206.5	207.8	--	--	--	--
maximum breadth	137.8	147.1	151.0	--	--	--	--	158.2	--	--	138.2	--
acetabulum height	52.8	51.3	46.4	--	--	--	54.1	53.9	--	--	55.1	--
acetabulum transv br	47.1	45.9	46.4	--	--	--	51.8	50.8	--	--	--	--
iliac height	127.2	128.3	130.0	--	--	--	132.6	131.4	--	--	124.8	--
iliac blade min br	52.8	54.1	56.2	--	--	--	60.0	60.7	--	--	55.1	--

Table D5. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
radius	x-8											
maximum length	230.2											
physiological length	223.9											
a-p neck diameter	10.1											
m-l neck diameter	12.1											
a-p head diameter	19.7											
m-l head diameter	19.6											
distal breadth	30.1											
ulna		y-7										
maximum length	--	--										
physiological length	--	--										
least circumference	--	--										
m-l midshaft diameter	--	--										
a-p midshaft diameter	--	--										
trochlear m-l diameter	--	--										
trochlear a-p diameter	--	20.4										
coronoid height	--	--										
olecranon a-p diameter	--	25.2										
trochlear length	--	19.7										
olecranon length	--	18.0										
proximal a-p diameter	--	16.2										
proximal m-l diameter	--	14.4										
distal breadth	--	--										
innominate		x-13		x-7								
maximum height	--	204.7	--	200.7								
maximum breadth	--	162.8	--	153.8								
acetabulum height	--	59.1	--	48.9								
acetabulum transv br	--	47.7	--	43.8								
iliac height	--	124.3	--	123.0								
iliac blade min br	--	58.9	--	54.2								

Table D6. Paired infracranial metric dimensions: femur.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
	a-7	a-2	b-54	b-52	d-3	d-15	e-19		g-2			h-8
maximum length	397.8	395.8	386.9	385.0	440.6	438.0	429.8	- -	453.1	- -	- -	- -
oblique length	393.5	389.7	380.0	381.0	435.4	434.0	426.7	- -	446.8	- -	- -	- -
a-p midshaft diam	25.9	24.7	25.0	26.0	30.6	26.9	31.0	- -	25.3	- -	- -	- -
m-l midshaft diam	22.7	23.2	23.8	22.0	27.0	26.7	28.7	- -	24.6	- -	- -	- -
head diameter	41.9	42.2	39.2	40.1	45.8	45.3	45.0	- -	44.9	- -	- -	47.4
midshaft circum	77.0	74.3	79.5	80.0	89.8	86.3	93.3	- -	79.8	- -	- -	- -
subtroch a-p diam	22.3	21.3	26.7	28.2	25.0	26.3	27.1	- -	23.2	- -	- -	25.9
subtroch m-l diam	26.2	28.7	30.9	32.9	31.3	32.8	34.1	- -	33.9	- -	- -	36.6
vertical neck diam	27.1	27.4	25.3	26.2	32.4	32.3	29.2	- -	29.4	- -	- -	32.1
a-p neck diameter	23.2	22.8	20.8	20.5	24.2	27.1	23.9	- -	27.1	- -	- -	28.2
proximal width	84.2	83.2	80.8	85.0	100.7	101.9	96.2	- -	87.1	- -	- -	96.3
neck length	34.1	29.0	40.2	45.0	44.8	50.8	43.8	- -	36.4	- -	- -	57.4
bicondylar breadth	- -	73.7	74.7	75.8	78.8	79.9	79.8	- -	75.4	- -	- -	- -
a-p diam dist shaft	36.1	36.0	33.0	32.5	38.9	36.8	39.4	- -	35.2	- -	- -	- -
a-p diam lat cond	60.2	58.2	58.1	59.8	63.1	62.9	64.0	- -	61.9	- -	- -	- -
a-p diam med cond	57.9	57.0	54.3	54.9	60.8	60.7	68.3	- -	61.8	- -	- -	- -
m-l diam lat cond	28.3	34.8	25.7	27.5	24.7	26.0	28.0	- -	27.9	- -	- -	- -
m-l diam med cond	- -	29.7	25.3	26.7	27.6	27.0	28.7	- -	24.4	- -	- -	- -
condylar notch br	23.7	22.4	20.9	20.1	20.8	22.1	21.3	- -	18.1	- -	- -	- -

Table D6. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
	i-53	i-55	i-56	i-57	m-11	m-15	n-5	n-7	r-3	r-1		t-1
maximum length	452.1	--	--	--	--	--	--	--	--	--	--	487.5
oblique length	450.0	--	--	--	--	--	--	--	--	--	--	486.0
a-p midshaft diam	35.0	24.8	24.5	34.2	23.8	23.3	25.0	25.2	28.7	--	--	30.5
m-l midshaft diam	29.8	22.8	25.5	28.0	22.2	22.6	24.4	24.6	26.1	--	--	29.4
head diameter	49.4	--	--	48.8	--	--	41.2	41.9	--	--	--	49.8
midshaft circum	103.2	74.4	77.2	102.0	73.4	72.8	77.0	78.2	--	--	--	94.8
subtroch a-p diam	32.7	22.9	22.4	28.2	22.9	23.8	23.3	24.0	27.8	--	--	39.9
subtroch m-l diam	37.1	31.2	30.2	36.8	31.1	32.0	31.1	31.9	32.7	--	--	32.2
vertical neck diam	37.7	29.9	25.9	34.9	--	--	26.2	--	--	--	--	37.1
a-p neck diameter	27.8	21.2	22.2	25.9	--	--	23.1	--	--	--	--	31.1
proximal width	107.1	--	89.0	109.2	--	--	90.1	--	--	--	--	106.3
neck length	89.0	--	36.1	44.2	--	--	33.1	--	--	--	--	36.9
bicondylar breadth	85.8	--	--	--	--	--	--	--	--	--	--	--
a-p diam dist shaft	37.8	29.3	--	41.8	38.8	--	--	--	34.9	--	--	44.0
a-p diam lat cond	67.6	60.1	--	69.5	63.9	--	--	--	--	--	--	66.8
a-p diam med cond	66.3	60.0	--	--	--	--	--	--	--	--	--	--
m-l diam lat cond	33.8	30.4	--	--	25.7	23.0	20.9	--	--	--	--	41.5
m-l diam med cond	37.6	--	--	--	--	24.4	--	--	--	--	--	--
condylar notch br	24.1	28.2	--	--	--	19.9	--	--	--	--	--	--

Table D6. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
	u-1		v-1	v-9	v-3	v-6	v-2	v-4	w-2	w-1	x-10	
maximum length	--	--	447.8	453.7	454.8	--	448.0	443.7	--	--	450.0	--
oblique length	--	--	445.5	451.0	451.0	--	439.5	441.5	--	--	442.8	--
a-p midshaft diam	--	--	27.7	27.0	27.8	--	28.5	29.0	25.9	25.0	26.9	--
m-l midshaft diam	--	--	24.2	26.8	24.8	26.8	25.6	27.8	22.9	23.9	22.0	--
head diameter	--	--	42.9	46.4	46.3	--	44.1	42.0	42.3	--	41.0	--
midshaft circum	--	--	83.0	85.5	82.4	85.0	85.2	88.4	78.0	80.0	78.3	--
subtroch a-p diam	26.3	--	25.8	21.2	21.2	--	24.3	25.0	22.6	21.4	24.2	--
subtroch m-l diam	35.8	--	35.5	34.1	32.2	--	29.1	33.3	30.8	31.1	31.3	--
vertical neck diam	--	--	25.7	31.7	30.2	--	26.3	26.8	28.3	--	27.2	--
a-p neck diameter	--	--	20.9	26.8	24.7	--	24.9	21.0	23.0	--	25.6	--
proximal width	--	--	88.9	97.1	96.0	--	87.0	93.0	77.2	--	83.1	--
neck length	--	--	21.2	31.8	34.2	--	32.4	34.1	--	--	38.1	--
bicondylar breadth	--	--	73.9	85.4	--	--	79.5	74.1	--	--	77.8	--
a-p diam dist shaft	--	--	38.1	31.0	38.1	--	30.9	38.0	--	--	35.0	--
a-p diam lat cond	--	--	62.2	66.3	68.0	--	65.2	60.5	--	--	60.0	--
a-p diam med cond	--	--	61.1	67.9	65.0	--	64.1	58.9	--	--	58.8	--
m-l diam lat cond	--	--	28.9	30.0	30.5	--	26.0	26.0	--	--	25.6	--
m-l diam med cond	--	--	26.1	30.1	29.9	--	25.9	26.7	--	--	25.1	--
condylar notch br	--	--	16.6	22.8	23.1	--	21.2	18.4	--	--	23.2	--

Table D6. Continued.

descriptor	l	r
	y-2	y-1
maximum length	--	--
oblique length	--	--
a-p midshaft diam	--	--
m-l midshaft diam	--	--
head diameter	--	--
midshaft circum	--	--
subtroch a-p diam	25.2	28.2
subtroch m-l diam	29.5	22.3
vertical neck diam	29.9	26.2
a-p neck diameter	24.0	24.6
proximal width	--	--
neck length	--	--
bicondylar breadth	--	--
a-p diam dist shaft	--	--
a-p diam lat cond	--	--
a-p diam med cond	--	--
m-l diam lat cond	--	--
m-l diam med cond	--	-
condylar notch br	--	--

Table D7. Paired infracranial metric dimensions: patella, tibia, fibula, talus and calcaneus.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
patella	a-48	a-49				b-57						
maximum length	37.2	35.8	--	--	--	40.1	--	--	--	--	--	--
maximum breadth	40.9	38.8	--	--	--	43.7	--	--	--	--	--	--
tibia	a-9	a-3	b-2	b-3	b-56	b-55	d-4	d-5	e-23	e-24/25	g-3	g-5
maximum length	325.9	317.3	350.3	351.2	319.2	320.7	370.5	373.8	--	--	385.2	390.9
a-p diam at nut for	27.2	25.9	--	--	33.2	33.1	--	39.4	--	--	34.5	33.8
m-l diam at nut for	20.0	18.2	--	--	22.0	23.3	--	26.7	--	--	23.0	22.9
proximal a-p diameter	46.8	45.1	--	--	45.6	45.4	--	48.3	--	51.7	46.2	47.6
proximal m-l diameter	67.9	--	--	--	67.9	68.9	74.8	75.7	--	--	69.9	77.3
distal diameter	44.2	--	46.1	49.8	43.9	41.3	47.9	47.8	42.2	45.0	43.9	46.7
fibula	a-14	a-15					d-11	d-7			g-10	g-9
maximum length	314.0	310.9	--	--	--	--	356.0	353.0	--	--	--	371.9
talus	a-82	a-85			b-63	b-65						g-51
maximum length	46.8	--	--	--	45.9	48.1	--	--	--	--	--	45.1
transverse troch br	29.1	--	--	--	27.8	28.9	--	--	--	--	--	27.6
maximum trochlear ht	28.6	--	--	--	27.9	28.3	--	--	--	--	--	28.9
maximum breadth	39.1	--	--	--	39.2	39.2	--	--	--	--	--	39.5
calcaneus	a-84	a-83			b-61	b-62					g-52	g-53
maximum length	65.4	64.8	--	--	78.1	77.9	--	--	--	--	74.9	74.1
minimum breadth	22.4	22.5	--	--	39.7	41.1	--	--	--	--	25.9	25.9
height	34.8	35.6	--	--	27.3	27.6	--	--	--	--	37.9	37.1

Table 07. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
patella				i-163		i-167			m-25	m-26		
maximum length	--	--	--	42.6	--	--	--	--	39.8	--	--	--
maximum breadth	--	--	--	37.2	--	--	--	--	38.3	38.8	--	--
tibia		h-12	i-47	i-49	i-50	i-51	i-52	i-58	m-10	m-6	n-10	n-9
maximum length	--	--	383.2	--	346.5	344.6	355.0	--	--	--	356.3	365.7
a-p diam at nut for	--	--	39.3	38.2	29.9	28.3	29.6	28.3	29.6	30.0	29.8	34.2
m-l diam at nut for	--	--	24.9	17.7	19.2	19.9	17.2	25.2	21.1	22.3	23.0	22.9
proximal a-p diameter	--	--	--	--	--	42.2	--	--	--	--	50.4	52.1
proximal m-l diameter	--	--	--	--	65.8	68.2	--	--	--	--	--	74.2
distal diameter	--	--	56.9	--	43.0	42.0	42.0	48.8	--	--	--	46.8
fibula		h-13	i-31	i-30		i-36		i-32	m-9	m-5	n-11	
maximum length	--	--	371.3	--	--	--	--	--	--	--	351.0	--
talus			i-166	i-164	i-179							
maximum length	--	--	46.2	49.3	--	--	--	--	--	--	--	--
transverse troch br	--	--	28.8	27.7	--	--	--	--	--	--	--	--
maximum trochlear ht	--	--	29.8	30.2	--	--	--	--	--	--	--	--
maximum breadth	--	--	39.5	41.1	--	--	--	--	--	--	--	--
calcaneus												
maximum length	--	--	--	--	--	--	--	--	--	--	--	--
minimum breadth	--	--	--	--	--	--	--	--	--	--	--	--
height	--	--	--	--	--	--	--	--	--	--	--	--

Table D7. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
patella												
maximum length	--	--	--	--	--	--	--	--	--	--	--	--
maximum breadth	--	--	--	--	--	--	--	--	--	--	--	--
tibia	r-4	r-2					v-5	v-19		w-3	x-9	x-11
maximum length	356.1	363.8	--	--	--	--	--	--	--	--	376.6	376.2
a-p diam at nut for	--	--	--	--	--	--	--	--	--	--	29.9	30.1
m-l diam at nut for	--	--	--	--	--	--	--	--	--	--	22.9	22.3
proximal a-p diameter	45.6	--	--	--	--	--	48.8	--	--	--	45.6	--
proximal m-l diameter	--	--	--	--	--	--	69.4	--	--	--	72.4	72.3
distal diameter	--	--	--	--	--	--	--	46.0	--	--	43.8	44.2
fibula								v-8	w-31	w-28		
maximum length	--	--	--	--	--	--	--	--	--	--	--	--
talus			s-8		s-15				w-36	w-35		
maximum length	--	--	43.2	--	47.1	--	--	--	43.8	44.4	--	--
transverse troch br	--	--	23.4	--	29.9	--	--	--	--	24.8	--	--
maximum trochlear ht	--	--	22.3	--	26.9	--	--	--	22.8	23.9	--	--
maximum breadth	--	--	33.2	--	37.8	--	--	--	34.9	--	--	--
calcaneus									w-34			
maximum length	--	--	--	--	--	--	--	--	--	--	--	--
minimum breadth	--	--	--	--	--	--	--	--	--	--	--	--
height	--	--	--	--	--	--	--	--	--	--	--	--

Table D7. Continued.

descriptor	l	r
patella		y-4
maximum length	--	--
maximum breadth	--	--
tibia	y-6	
maximum length	--	--
a-p diam at nut for	--	--
m-l diam at nut for	--	--
proximal a-p diameter	--	--
proximal m-l diameter	--	--
distal diameter	--	--
fibula		
maximum length	--	--
talus	y-24	y-23
maximum length	44.3	45.2
transverse troch br	23.3	24.2
maximum trochlear ht	27.0	28.0
maximum breadth	--	--
calcaneus	y-26	y-25
maximum length	--	--
minimum breadth	--	--
height	--	--

Table D8. Paired infracranial metric dimensions: metacarpals.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
	a-108	a-113	e-39			g-59			m-30			s-38
length #1	39.4	39.6	46.2	--	--	48.2	--	--	--	--	--	42.0
rad-uln mid diam #1	9.5	9.4	11.1	--	--	10.4	--	--	10.5	--	--	10.8
dor-pal mid diam #1	6.9	7.4	8.2	--	--	7.3	--	--	7.2	--	--	7.9
	a-110	a-106	e-41	e-37					m-31		s-19	s-76
length #2	59.8	62.1	67.3	69.4	--	--	--	--	--	--	60.8	--
rad-uln mid diam #2	6.3	6.2	7.4	7.9	--	--	--	--	7.0	--	6.9	6.2
dor-pal mid diam #2	7.9	8.2	8.3	8.5	--	--	--	--	8.0	--	8.1	8.6
	a-112	a-107	e-40	e-36	g-56				m-32		s-23	s-77
length #3	60.1	61.4	67.7	69.0	71.1	--	--	--	61.6	--	62.9	--
rad-uln mid diam #3	6.7	7.1	7.2	8.0	7.9	--	--	--	6.5	--	7.0	6.2
dor-pal mid diam #3	8.1	7.9	9.4	9.4	10.1	--	--	--	7.8	--	7.9	8.5
		a-109	e-43	e-42			h-45				s-21	s-18
length #4	--	51.7	60.5	59.4	--	--	65.1	--	--	--	54.5	55.9
rad-uln mid diam #4	--	5.7	6.1	5.6	--	--	7.8	--	--	--	5.3	6.2
dor-pal mid diam #4	--	6.6	7.0	6.8	--	--	8.9	--	--	--	6.9	7.6
		a-111	e-44	e-45								s-20
length #5	--	45.8	54.8	54.9	--	--	--	--	--	--	--	48.3
rad-uln mid diam #5	--	7.3	7.0	7.3	--	--	--	--	--	--	--	8.7
dor-pal mid diam #5	--	5.5	6.7	6.1	--	--	--	--	--	--	--	6.1

Table D8. Continued.

descriptor		l	r
		s-78	
length	#1	--	38.9
rad-uln mid diam	#1	--	10.6
dor-pal mid diam	#1	--	8.1
		s-36	
length	#2	63.1	--
rad-uln mid diam	#2	8.0	--
dor-pal mid diam	#2	8.1	--
length	#3	--	--
rad-uln mid diam	#3	--	--
dor-pal mid diam	#3	--	--
		s-79	
length	#4	53.1	--
rad-uln mid diam	#4	5.9	--
dor-pal mid diam	#4	7.0	--
		s-39	
length	#5	--	48.1
rad-uln mid diam	#5	--	7.0
dor-pal mid diam	#5	--	6.0

Table D9. Paired infracranial metric dimensions: metatarsals.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
	a-108	a-113				e-34	g-62		h-43			
length #1	39.4	39.6	--	--	--	61.1	66.1	--	63.4	--	--	--
fib-tib mid diam #1	11.2	11.0	--	--	--	14.1	12.3	--	14.0	--	--	--
sup-pla mid diam #1	11.0	12.1	--	--	--	12.0	10.8	--	13.5	--	--	--
	a-97			b-69		e-33	g-57				i-170	
length #2	64.8	--	--	67.6	--	78.6	76.9	--	--	--	72.1	--
fib-tib mid diam #2	7.0	--	--	7.0	--	8.8	7.2	--	--	--	7.6	--
sup-pla mid diam #2	7.5	--	--	10.1	--	9.7	7.2	--	--	--	7.8	--
	a-92					e-35	g-61			h-46	i-171	
length #3	60.1	--	--	--	--	73.7	71.9	--	--	--	65.3	--
fib-tib mid diam #3	5.8	--	--	--	--	7.9	8.0	--	--	7.9	6.2	--
sup-pla mid diam #3	7.3	--	--	--	--	8.8	8.1	--	--	9.1	8.2	--
	a-98	a-96		b-68		e-49	g-54	g-58			i-172	
length #4	60.9	61.5	--	58.7	--	70.6	73.6	71.1	--	--	63.8	--
fib-tib mid diam #4	5.7	6.3	--	6.1	--	8.9	6.3	6.2	--	--	6.1	--
sup-pla mid diam #4	9.2	8.5	--	9.3	--	9.7	8.4	9.2	--	--	8.4	--
		a-93				e-32	g-55	g-60		h-44	i-168	i-169
length #5	--	63.2	--	--	--	71.3	70.9	70.2	--	--	64.4	--
fib-tib mid diam #5	--	6.8	--	--	--	9.9	12.3	11.8	--	10.7	10.2	10.8
sup-pla mid diam #5	--	9.7	--	--	--	7.8	6.3	5.9	--	7.9	6.6	7.1

Table D9. Continued.

descriptor	l	r	l	r	l	r	l	r
			s-32			w-39	y-29	y-28
length #1	--	--	55.6	--	--	--	--	--
fib-tib mid diam #1	--	--	13.0	--	--	11.9	12.9	12.0
sup-pla mid diam #1	--	--	12.5	--	--	12.1	--	--
length #2	--	--	--	--	--	--	--	--
fib-tib mid diam #2	--	--	--	--	--	--	--	--
sup-pla mid diam #2	--	--	--	--	--	--	--	--
	i-174						y-31	
length #3	--	--	--	--	--	--	--	--
fib-tib mid diam #3	5.2	--	--	--	--	--	9.0	--
sup-pla mid diam #3	7.1	--	--	--	--	--	7.5	--
		i-173			w-40		y-32	y-33
length #4	--	--	--	--	68.0	--	--	--
fib-tib mid diam #4	--	--	--	--	7.1	--	5.2	5.9
sup-pla mid diam #4	--	--	--	--	8.3	--	9.2	8.0
					w-38	w-37	y-34	
length #5	--	--	--	--	--	--	--	--
fib-tib mid diam #5	--	--	--	--	9.3	8.4	--	--
sup-pla mid diam #5	--	--	--	--	7.0	6.6	--	--

Table D10. Unpaired infracranial metric dimensions.

descriptor							
a. atlas	a-25				h-15	i-68	
external br	73.8	--	--	--	81.2	--	--
external ln	38.9	--	--	--	44.5	44.1	--
internal br	25.7	--	--	--	30.0	26.1	--
internal ln	27.8	--	--	--	30.8	30.1	--
b. axis	a-27	b-40				i-67	
external br	53.2	50.8	--	--	--	50.7	--
external ln	45.2	--	--	--	--	43.7	--
c. C7	a-24				h-26		
body br	29.1	--	--	--	27.8	--	--
body ln	17.9	--	--	--	14.1	--	--
d. T12	a-36	b-38		g-45			
body br	33.3	41.4	--	36.2	--	--	--
body ln	28.4	31.4	--	28.0	--	--	--
e. L5		b-50	e-7	g-49	h-17		w-44
body br	--	56.2	55.2	61.8	55.6	--	42.9
body ln	--	32.3	32.9	29.5	32.3	--	29.4
f. sternum	a-23/28					i-165	
manubrium ln	48.4	--	--	--	--	--	--
maximum body br	44.3	--	--	--	--	84.1	--
maximum body ln	125.8	--	--	--	--	36.9	--
g. sacrum	a-21		e-5	g-15			w-5
maximum height	118.6	--	112.8	93.2	--	--	--
maximum breadth	106.0	--	119.9	111.1	--	--	119.7

Table D11. Paired juvenile infracranial metric dimensions.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
a. clavicle												
length	--	--	--	--	--	--	--	--	--	--	--	--
b. scapula	f-5				j-23	j-20						
length	--	--	--	--	--	93.8	--	--	--	--	--	--
breadth	64.9	--	--	--	65.3	65.5	--	--	--	--	--	--
c. humerus	f-4											
length	196.1	--	--	--	--	--	--	--	--	--	--	--
prox metaphysis br	27.5	--	--	--	--	--	--	--	--	--	--	--
dist metaphysis br	37.6	--	--	--	--	--	--	--	--	--	--	--
d. radius								n-1	p-3			
length	--	--	--	--	--	--	--	146.4	145.1	--	--	--
e. ulna									p-1			
length	--	--	--	--	--	--	--	--	160.3	--	--	--
f. ilium											v-30	
length	--	--	--	--	--	--	--	--	--	--	30.2	--
breadth	--	--	--	--	--	--	--	--	--	--	34.9	--
g. femur				i-150								
length	--	--	--	237.1	--	--	--	--	--	--	--	--
prox metaphysis br	--	--	--	46.2	--	--	--	--	--	--	--	--
dist metaphysis br	--	--	--	51.1	--	--	--	--	--	--	--	--
h. tibia								n-2				v-27
length	--	--	--	--	--	--	--	194.0	--	--	--	98.7
i. fibula												
length	--	--	--	--	--	--	--	--	--	--	--	--

APPENDIX E

Non-Metric Descriptors of the
Cranial and Infracranial Skeleton

Key to non-metric sources

Berry and Berry 1967 (BB)
Carpenter 1976 (C)
El-Najjar and McWilliams 1978 (EM)
Finnegan 1978 and Finnegan and Faust 1974 (F)
Ossenberg 1970, 1974, 1976 (O)
Saunders 1978 (S)

Scoring Key

0-3 = levels of expression (0=no expression, 1=mild expression, 2=moderate expression, 3=maximum expression)

+	= present	-	= absent
na	= not available	m	= present, multiple
s	= single	d	= double
a	= absent	b	= bipartite
n	= notch	f	= foramen
ex	= extrasutural	st	= sutural
sr	= straight	c	= complete
i	= incomplete	ev	= everted
iv	= inverted	ant	= anterior
pst	= posterior	r	= right
lt	= left		

a) cranial

trochlear spur (O)	present (+)/absent (-)
supraorbital foramen (O)	notch (n)/foramen (f)
frontal groove (O)	present (+)/absent (-)
supratrochlear foramen (O)	present (+)/absent (-)
infraorbital suture (O)	present (+)/absent (-)
infraorbital foramen (BB)	present (+)/absent (-)
accessory optic canal (O)	present (+)/absent (-)
frontal foramen (BB)	present (+)/absent (-)
anterior ethmoid foramen (BB)	present (+)/absent (-)
posterior ethmoid foramen (BB)	sutural (st)/extrasutural (ex)
maxillary torus (EM)	present (+)/absent (-)
accessory lesser palatine foramen (EM)	present (+)/absent (-)
zygomatic facial foramen (BB)	present (+)/absent (-)/multiple (m)
os japonicum (EM)	present (+)/absent (-)
parietal notch bone (BB)	present (+)/absent (-)
parietal foramen (BB)	present (+)/absent (-)/multiple (m)
pterion shape (EM)	see El-Najjar and McWilliams 1978:125
auditory torus (BB)	present (+)/absent (-)
mastoid foramen (BB)	sutural (st)/extrasutural (ex)/absent (a)
auditory exostoses (O)	present (+)/absent (-)
foramen of Hushke (BB)	present (+)/absent (-)
parietal process (O)	present (+)/absent (-)
marginal foramen of the tympanic plate (O)	present (+)/absent (-)
suprameatal pit (EM)	present (+)/absent (-)
squamoparietal synostosis (O)	present (+)/absent (-)
condylar facet (BB)	single (s)/double (d)
anterior palatine alveolar foramen (EM)	present (+)/absent (-)/multiple (m)
posterior condylar canal (BB)	present (+)/absent (-)
precondylar tubercle (BB)	present (+)/absent (-)
anterior condylar canal (BB)	single (s)/double (d)
foramen ovale (BB)	complete (c)/incomplete (i)
foramen spinosum (BB)	complete (c)/incomplete (i)
lambdoid ossicles (BB)	present (+)/absent (-)/multiple (m)
ossicle at asterion (BB)	present (+)/absent (-)
intermediate condylar canal (O)	present (+)/absent (-)
paracondylar process (O)	0-3
foramen of vesalius (O)	present (+)/absent (-)
accessory mylohyoid foramen (C)	present (+)/absent (-)
mylohyoid bridge (O)	present (+)/absent (-)
mylohyoid bridge (lingula) (O)	present (+)/absent (-)
mandibular torus (EM)	0-3
gonial angle (EM)	inverted (in)/everted (ev)/straight (sr)
accessory mental foramen (EM)	multiple (m)
mental alveolar foramen (EM)	present (+)/absent (-)/multiple (m)
metopism (O)	present (+)/absent (-)
bregmatic bone (BB)	present (+)/absent (-)
nasal bone shape (EM)	see El-Najjar and McWilliams 1978:143
transverse palatine suture (EM)	anterior (ant)/posterior (pst)/straight (sr)

palatine torus (EM)	0-3
coronal ossicles (BB)	present (+)/absent (-)/multiple (m)
highest nuchal line (BB)	present (+)/absent (-)
ossicle at lambda (BB)	present (+)/absent (-)
odonto-occipital articulation (O)	present (+)/absent (-)
pharyngeal fossa (EM)	present (+)/absent (-)
superior sagittal sulcus (EM)	straight (sr)/right (r)/left (lt)

b) infracranial

clavicle	
rhomboid fossa (S)	0-3
subclavian facet (S)	0-3
scapula	
circumflex sulcus (F)	present (+)/absent (-)
suprascapular foramen (F)	present (+)/absent (-)
acromial articular facet (F)	present (+)/absent (-)
unfused acromion (S)	present (+)/absent (-)
humerus	
supracondyloid process (F)	present (+)/absent (-)
septal aperture (F)	present (+)/absent (-)
ulna	
trochlear notch form (S)	single (s)/double (d)
innominate	
acetabular crease (F)	present (+)/absent (-)
accessory sacral facet (F)	present (+)/absent (-)
femur	
poirier's facet (F,S)	present (+)/absent (-)
allen's fossa (F,S)	present (+)/absent (-)
hypertrochanteric fossa (F)	0-3
exostoses in trochanteric fossa (F)	present (+)/absent (-)
third trochanter (F)	0-3
patella	
vastus notch (F)	0-3
tibia	
medial squatting facet (F)	present (+)/absent (-)
lateral squatting facet (F)	present (+)/absent (-)

<u>talus</u>	
os trigonum (F,S)	present (+)/absent (-)
medial talar facet (F)	present (+)/absent (-)
lateral talar extension (F)	present (+)/absent (-)
inferior talar articular surface (F)	single (s)/double (d)
<u>calcaneus</u>	
peroneal tubercle (S)	0-3
anterior calcaneal facet (S)	single (s)/double (d)/bipartite (b) /absent (a)
<u>vertebrae</u>	
atlas facet form (F)	single (s)/double (d)
posterior bridge (F)	present (+)/absent (-)
lateral bridge (F)	present (+)/absent (-)
transverse foramen bipartite (F)	# of vertebrae displaying trait
<u>sacrum</u>	
accessory sacral facet (F)	present (+)/absent (-)

Table E1. Paired infracranial non-metric characteristics.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
a. clavicle	a-50	a-51		b-9	b-59			d-6			g-50	
rhomboid fossa	1	1		1	0			0			1	
subclavian facet	1	1		0	1			1			na	
b. scapula	a-16	-17		b-10	b-58						g-11	g-12
circumflex sulcus	+	+		na	-						+	+
suprascapular for	-	-		-	-						na	-
acromial art facet	-	na		na	-						-	-
unfused acromion	-	na		na	-						-	-
c. humerus	a-8	a-1		b-4			d-10	d-9	e-21		g-4	g-6
supracondyloid proc	-	-		-			-	-	-		-	-
septal aperture	-	-		-			+	+	-		+	-
d. ulna	a-12	a-13		b-8			d-8	d-14	e-22			g-8
troch notch form	s	s		s			s	s	s			s
e. innominate	a-18	a-19		b-16		b-70	d-2		e-4	e-3	g-14	g-13
acetabular crease	-	-		-		-	-		-	-	-	-
access sacral facet	-	-		+		na	-		-	-	+	-
f. femur	a-17	a-2			b-54	b-52	d-7	d-15	e-19		g-2	
poirier's facet	-	-			-	-	+	+	-		-	
allen's fossa	-	-			-	-	-	+	+		-	
hypertroch fos	0	0			1	1	0	1	0		1	
exos in troch fossa	-	-			-	-	-	-	-		+	
third trochanter	2	0			0	0	1	0	0		1	
g. patella	a-49	a-49				b-57						
vastus notch	1	1				1						
h. tibia	a-9	a-3	b-2	b-3	b-56	b-55	d-4	d-5	e-23	e-24	g-3	g-5
med squatting facet	-	na	-	-	-	-	-	-	-	-	-	-
lat squatting facet	+	na	-	+	-	+	-	+	-	+	+	-

Table E1. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
i. talus	a-82	a-85			b-63	b-65						g-51
os trigonum	-	-			+	-						+
medial talar facet	-	na			-	-						-
lateral talar ext	-	na			-	-						-
inf talar art surface	d	na			d	d						d
j. calcaneus	a-84	a-83			b-61	b-62					g-52	g-53
peroneal tubercle	1	1			2	2					2	2
ant calcaneal facet	d	d			d	d					a	a

Table E1. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
a. clavicle	h-40	h-39	i-152	i-153						m-29		
rhomboid fossa	1	2	1	3						na		
subclavian facet	0	1	0	0						2		
b. scapula	h-42	h-41	i-12	i-10	i-9	i-14	i-11	i-13		m-27		
circumflex sulcus	-	-	+	-	-	+	-	-		na		
suprascapular for	na	-	na	-	-	-	-	na		na		
acromial art facet	na	na	na	-	-	na	na	-		-		
unfused acromion	na	na	na	-	na	na	-			na		
c. humerus		h-9	i-48	i-43	i-45	i-42	i-21	i-44	m-7	m-12		n-6
supracondyloid proc		-	-	-	-	-	na	-	-	-		-
septal aperture		-	+	-	-	+	+	+	-	-		-
d. ulna			i-33	i-40	i-34	i-41			m-4	m-14		
troch notch form			s	d	na	s			s	s		
e. innominate	h-38	h-37	i-16	i-76	i-19		i-17			m-16		
acetabular crease	-	-	-	-	-		-			-		
access sacral facet	-	-	na	-	na		-			na		
f. femur		h-8	i-53	i-55	i-56	i-57			m-11	m-15	n-5	n-7
poirier's facet		+	+	na	-	+			na	na	+	-
allen's fossa		-	-	na	-	-			na	na	-	+
hypertroch fos		2	1	0	0	1			1	1	1	1
exos in troch fossa		-	+	-	-	+			-	-	-	na
third trochanter		2	3	0	1	1			1	2	1	0
g. patella				i-167		i-163			m-25	m-26		
vastus notch				1		1			-	-		
h. tibia			i-52	i-51	i-47	i-58	i-50		e-23	e-24	n-10	n-9
med squatting facet			-	-	-	-	-		-	-	-	-
lat squatting facet			-	+	+	-	+		-	+	-	-

Table E1. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
i. talus			l-166	l-164								
os trigonum			-	-								
medial talar facet			-	-								
lateral talar ext			-	-								
inf talar art surface			d	d								
j. calcaneus												
peroneal tubercle												
ant calcaneal facet												

Table E1. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
a. clavicle					s-99	s-75						
rhomboid fossa					0	1						
subclavian facet					1	1						
b. scapula											v-57	v-58
circumflex sulcus											-	+
suprascapular for											na	na
acromial art facet											-	na
unfused acromion											-	na
c. humerus											v-12	v-14
supracondyloid proc											-	-
septal aperture											+	+
d. ulna											v-13	
troch notch form											S	
e. innominate		q-1			s-3	s-1					v-60	v-59
acetabular crease		-			~	-					-	-
access sacral facet		-			~	na					-	-
f. femur			r-3	r-1						t-1	v-1	v-4
poirier's facet			na	na						+	-	-
allen's fossa			na	na						-	-	-
hypertroch fos			0	0						1	0	1
exos in troch fossa			-	na						+	+	+
third trochanter			0	0						1	na	1
g. patella												
vastus notch												
h. tibia												v-19
med squatting facet												-
lat squatting facet												+

Table E1. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
i. talus					s-15		s-8					
os trigonum					-		+					
medial talar facet					+		-					
lateral talar ext					-		-					
inf talar art surface					s		d					
j. calcaneus					s-45							
peroneal tubercle					na							
ant calcaneal facet					s							

Table E1. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
a. clavicle												
rhomboid fossa												
subclavian facet												
b. scapula					w-9		x-3					
circumflex sulcus					-		-					
suprascapular for					na		na					
acromial art facet					na		na					
unfused acromion					na		na					
c. humerus					w-29	w-24	x-12					
supracondyloid proc					-	-	-					
septal aperture					-	-	-					
d. ulna					w-27	w-26					y-7	
troch notch form					s	s					S	
e. innominate					w-6			x-7		x-13		
acetabular crease					-			-		-		
access sacral facet					na			-		+		
f. femur	v-2	v-6	v-3	v-9	w-2		x-10				y-2	y-1
poirier's facet	-	na	-	-	-		-				-	-
allen's fossa	-	na	+	+	-		-				-	-
hypertroch fos	1	3	1	1	0		1				1	1
exos in troch fossa	+	na	-	-	-		-				na	na
third trochanter	2	na	2	2	0		0				0	0
g. patella												
vastus notch												
h. tibia							x-9	x-11				
med squatting facet							-	-				
lat squatting facet							+	+				

Table E1. Continued.

descriptor	l	r	l	r	l	r	l	r	l	r	l	r
i. talus											y-24	y-23
os trigonum											+	-
medial talar facet											+	+
lateral talar ext											-	-
inf talar art surface											d	d
j. calcaneus					w-34						y-26	y-25
peroneal tubercle					na						na	na
ant calcaneal facet					d						s	s

Table E2. Paired cranial non-metric characteristics.

descriptor	a-1		c-1		c-2		e-1		d-1		h-2	
	l	r	l	r	l	r	l	r	l	r	l	r
trochlear spur	-	-	-	-	-	-	-	-	+	-	-	-
supraorbital for	n	n	n(m)	n	n	n	n	n	f	f	f	n
frontal groove	-	-	-	-	+	-	-	-	-	-	-	-
supratrochlear for	-	-	-	-	+	-	-	-	+	+	-	-
infraorbital suture	-	-	-	-	-	-	-	-	-	-	-	na
infraorbital for	+	-	+	-	-	-	+	m	-	-	-	na
acc optic canal	-	-	na	na	-	-	-	-	-	-	na	na
frontal foramen	+	+	+	+	-	+	-	+	+	+	-	-
ant ethmoid foramen	ex	st	ex	ex	st	ex	ex	ex	ex	ex	na	na
post ethmoid foramen	+	-	+	na	+	+	+	+	+	+	na	na
maxillary torus	-	-	+	+	-	-	+	-	-	+	-	-
acc less palat for	+	-	+	+	-	+	-	+	+	+	-	na
zygomatic fac for	m	m	m	+	-	+	m	-	m	-	+	+
os japonicum	-	+	-	-	+	+	-	-	-	-	na	na
parietal notch bone	-	-	-	-	-	-	-	-	-	-	-	-
parietal foramen	+	-	+	+	-	+	-	-	-	+	-	+
pterion shape	h	h	e	h	h	h	e	h	h	h	na	na
auditory torus	-	-	-	-	-	-	-	-	-	-	-	-
mastoid foramen	ex	ex	ex	ex(m)	ex(m)	-	st	ex	-	st	ex	ex,st
auditory exostoses	-	-	-	-	-	-	-	-	-	-	-	-
foramen of Hushke	-	-	-	-	+	+	-	-	-	-	-	-
parietal process	-	-	-	-	-	-	-	-	-	-	+	-
marg for tymp plate	-	-	-	-	-	-	-	-	-	-	+	+
suprameatal pit	+	+	-	-	+	+	+	-	+	+	+	+
squamoparietal synos	-	-	-	-	-	-	-	-	-	-	-	-
condylar facet	s	s	na	na	s	s	s	s	s	s	na	na
ant palat alv for	m	m	+	-	-	-	-	+	+	+	+	na
post cond canal	-	+	na	na	+	+	+	+	+	+	na	na
precondylar tubercle	-	+	na	na	-	-	-	-	-	-	na	na

Table E2. Continued.

descriptor	a-1 l	a-1 r	c-1 l	c-1 r	c-2 l	c-2 r	e-1 l	e-1 r	d-1 l	d-1 r	h-2 l	h-2 r
ant cond canal	s	s	na	na	s	s	s	s	s	d	na	na
foramen ovale	c	c	na	na	c	c	c	c	c	c	na	na
foramen spinosum	c	c	na	na	c	c	c	c	c	c	na	na
lambdoid ossicles	-	-	+	+	+	+	+	-	+	+	-	-
ossicle at asterion	-	-	-	-	-	-	-	-	+	+	+	-
inter cond canal	-	+	na	na	-	-	-	-	-	-	na	na
paracondylar process	-	-	na	na	-	+(1)	+(1)	+(1)	+(1)	na	na	na
for of vesalius	-	+	na	na	-	-	+	-	-	-	na	na
acc mylohyoid for	-	-	na	na	na	-	na	na	-	-	-	-
mylohyoid bridge	+	-	na	na	na	+	na	na	+	m	-	-
mylohy bridge (ling)	-	-	na	na	na	-	na	na	-	-	-	-
mandibular torus	-	-	na	na	na	+	na	na	-	-	-	+(1)
gonial angle	sr	sr	na	na	na	ev	na	na	sr	ev	ev	ev
acc mental foramen	-	-	na	na	-	-	na	na	-	-	-	-
mental alv foramen	+	+	na	na	+	-	na	na	+	+	na	na

Table E2. Continued.

descriptor	i-1		i-2		k-1		m-1		0-6		v-44	
	l	r	l	r	l	r	l	r	l	r	l	r
trochlear spur	-	-	-	-	-	-	-	-	-	-	-	-
supraorbital for	f	f	n	f	n	n	n	n	n	f	f	f
frontal groove(s)	-	-	-	-	-	-	-	-	+	+	-	-
supratrochlear for	-	-	-	-	-	-	-	-	-	-	-	-
infraorbital suture	-	-	na	na	-	-	na	na	+	+	-	na
infraorbital for	+	-	na	na	-	-	na	na	-	-	na	na
acc optic canal	-	-	-	-	-	-	na	na	-	-	na	na
frontal foramen	+	+	+	+	-	+	+	-	+	+	-	+
ant ethmoid foramen	ex	ex	ex	na	ex	st	na	na	ex	ex	na	na
post ethmoid foramen	+	+	+	na	+	+	na	na	+	+	na	na
maxillary torus	-	-	na	na	-	-	na	na	na	na	na	na
acc less palat for	m	m	na	na	+	+	ma	ma	ma	-	na	na
zygomatic fac for	+	m	+	na	+	m	+	m	m	m	m	m
os japonicum	-	-	-	na	na	na	-	-	na	-	-	-
parietal notch bone	-	-	-	-	-	-	-	-	-	-	na	-
parietal foramen	+	+	+	-	-	+	+	+	+	m	+	-
pterion shape	h	h	na	na	h	h	na	na	h	h	na	h
auditory torus	-	-	-	-	-	+	-	-	na	-	-	-
mastoid foramen	st	st	m	m	ex	st(m)	-	ex	na	ex(m)	-	-
auditory exostoses	-	-	-	-	-	-	-	-	na	-	-	-
foramen of Hushke	-	-	-	-	-	-	na	na	na	+	-	-
parietal process	-	-	-	-	-	-	-	na	-	-	-	+
marg for tymp plate	-	-	-	-	-	-	+	+	na	+	+	+
suprameatal pit	-	-	+	+	+	+	+	+	na	-	+	+
squamoparietal synos	-	-	+	-	-	-	-	-	-	-	-	-
condylar facet	s	s	s	s	na	na	na	na	na	na	na	na
ant palat alv for	+	-	na	na	-	-	na	na	na	na	na	na
post cond canal	-	-	+	+	+	+	na	na	na	na	na	na
precondylar tubercle	-	-	-	-	na	na	na	na	na	na	na	na

Table E2. Continued.

descriptor	l-1 l	l-1 r	l-2 l	l-2 r	k-1 l	k-1 r	m-1 l	m-1 r	0-6 l	0-6 r	v-44 l	v-44 r
ant cond canal	s	s	s	s	s	s	na	na	na	na	na	na
foramen ovale	c	c	c	c	c	c	na	c	na	na	c	c
foramen spinosum	c	c	i	i	c	c	na	c	na	na	i	i
lambdoid ossicles	-	-	-	-	-	-	-	+	+	+	-	-
ossicle at asterion	-	-	-	-	+	-	-	na	na	-	-	-
inter cond canal	-	-	-	-	-	-	na	na	na	na	na	na
paracondylar process	+(1)	-	+(1)	-	-	na	na	na	na	na	na	na
for of vesalius	-	-	-	-	-	-	na	-	na	na	-	-
acc mylohyoid for	+	-	-	-	na	na	-	-	na	-	na	na
mylohyoid bridge	+	-	-	+	na	na	+	-	na	na	na	na
mylohy bridge (ling)	-	-	-	-	na	na	-	-	-	na	na	na
mandibular torus	+(1)	+(1)	+(1)	-	na	na	-	-	na	na	na	na
gonial angle	ev	ev	ev	ev	na	na	iv	iv	na	na	na	na
acc mental foramen	-	-	-	-	na	na	-	-	na	na	na	na
mental alv foramen	+	+	+	+	na	na	-	-	na	na	na	na

Table E2. Continued.

descriptor	v-45 l	v-45 r	v-42 l	v-42 r	v-68 l	v-68 r	v-45 l	v-45 r	x-15 l	x-15 r	x-14 l	x-14 r
trochlear spur	-	-	-	-	-	-	na	na	-	+	-	-
supraorbital for	n	n	n	f	f	n	na	na	f	n	f	n
frontal groove	+	+	na	na	-	+	na	na	-	-	-	-
supratrochlear for	+	-	-	-	-	-	na	na	-	+	-	-
infraorbital suture	-	-	+	+	na	na	na	na	na	-	-	na
infraorbital for	-	-	-	-	na	na	na	na	na	-	-	na
acc optic canal	na	na	na	na	na	na	na	na	na	na	-	-
frontal foramen	+	-	na	na	na	na	na	na	m	-	-	-
ant ethmoid foramen	na	na	na	na	na	na	na	na	ex	ex	na	ex
post etmoid foramen	na	na	na	na	na	na	na	na	+	+	na	+
maxillary torus	-	-	-	-	na	na	na	na	na	-	na	na
acc less palat for	+	-	+	-	na	na	na	na	na	-	na	na
zygomatic fac for	-	na	m	+	na	na	na	na	na	-	m	na
os japonicum	-	na	-	-	na	na	na	na	na	-	-	na
parietal notch bone	-	-	na	na	na	na	na	na	-	-	+	-
parietal foramen	+	+	na	na	na	na	na	na	-	-	-	-
pterion shape	h	na	na	na	na	na	na	na	h	h	h	h
auditory torus	+	+	-	-	+	-	na	na	-	+	-	-
mastoid foramen	ex	st	ex,st	ex,st	na	st	na	na	st	st(m)	ex	ex
auditory exostoses	-	-	-	-	-	-	na	na	-	-	-	-
foramen of Hushke	-	-	-	-	-	-	na	na	-	-	-	-
parietal process	-	-	-	na	na	na	na	na	-	-	-	-
marg for tymp plate	-	-	+	+	na	na	na	na	+	-	+	+
suprameatal pit	+	+	+	+	na	na	na	na	-	-	+	+
squamoparietal synos	-	-	-	na	na	na	na	na	-	-	-	-
condylar facet	s	s	s	s	s	na	na	na	na	na	s	s
ant palat alv for	-	-	-	-	na	na	na	na	na	na	na	na
post cond canal	-	-	-	+	-	na	na	na	na	na	+	+
precondylar tubercle	-	-	-	-	na	na	na	na	na	na	-	-

Table E2. Continued.

descriptor	v-45 l	r	v-42 l	r	v-68 l	r	v-45 l	r	x-15 l	r	x-14 l	r
ant cond canal	s	d	d	s	s	na	na	na	na	na	s	s
foramen ovale	c	na	c	na	c	c	na	na	c	c	c	c
foramen spinosum	c	na	c	na	i	i	na	na	c	c	c	c
lambdoid ossicles	-	-	-	-	-	-	na	na	-	-	+	+
ossicle at asterion	-	-	-	-	na	-	na	na	-	-	-	-
inter cond canal	-	-	-	-	-	na	na	na	na	na	+	-
paracondylar process	+(2)	+(2)	na	na	na	na	na	na	na	na	-	+(1)
for of vesalius	-	na	-	na	na	na	na	na	na	na	+	-
acc mylohyoid for	na	na	+	na	na	na	na	-	na	na	na	na
mylohyoid bridge	na	na	+	na	na	na	-	-	na	na	na	na
mylohy bridge (ling)	na	na	-	na	na	na	-	-	na	na	na	na
mandibular torus	na	na	-	-	na	na	na	-	na	na	na	na
gonial angle	na	na	ev	na	na	na	na	ev	na	na	na	na
acc mental foramen	na	na	-	-	na	na	-	-	na	na	na	na
mental alv foramen	na	na	+	+	na	na	-	-	na	na	na	na

Table E2. Continued.

descriptor	y-3 l	y-3 r	z-1 l	z-1 r	aa-1 l	aa-1 r
trochlear spur	-	-	-	-	+	-
supraorbital for	f	f	n	n	n	n
frontal groove	na	na	-	-	-	-
supratrochlear for	na	na	-	-	-	-
infraorbital suture	na	na	na	-	-	-
infraorbital for	na	na	na	+	+	-
acc optic canal	na	na	na	-	-	-
frontal foramen	na	na	m	m	-	+
ant ethmoid foramen	na	na	ex	ex	s	ex
post etmoid foramen	na	na	+	+	+	+
maxillary torus	na	na	na	-	-	-
acc less palat for	na	na	na	+	-	-
zygomatic fac for	na	na	na	+	na	m
os japonicum	na	na	na	-	na	-
parietal notch bone	na	na	-	-	-	-
parietal foramen	na	na	+	+	-	+
pterion shape	na	na	na	h	h	h
auditory torus	na	na	na	na	-	-
mastoid foramen	na	na	na	na	na	ex
auditory exostoses	na	na	na	na	-	-
foramen of Hushke	na	na	na	na	-	-
parietal process	na	na	na	-	-	-
marg for tymp plate	na	na	na	na	-	-
suprameatal pit	na	na	na	na	-	-
squamoparietal synos	na	na	na	na	-	-
condylar facet	na	na	na	na	d	d
ant palat alv for	na	na	-	-	+	+
post cond canal	na	na	na	na	+	+
precondylar tubercle	na	na	na	na	-	-

Table E2. Continued.

descriptor	y-3 l	r	z-1 l	r	aa-1 l	r	l	r	l	r	l	r
ant cond canal	na	na	na	na	s	s						
foramen ovale	na	na	na	na	c	c						
foramen spinosum	na	na	na	na	c	c						
lambdoid ossicles	na	na	na	na	-	-						
ossicle at asterion	na	na	na	+	-	-						
inter cond canal	na	na	na	na	-	-						
paracondylar process	na	na	na	na	-	-						
for of vesalius	na	na	na	na	-	-						
acc mylohyoid for	na	+	na	na	na	na						
mylohyoid bridge	-	na	na	na	na	na						
mylohy bridge (ling)	-	-	na	na	na	na						
mandibular torus	+(1)	+(1)	na	na	na	na						
gonial angle	iv	ev	na	na	na	na						
acc mental foramen	-	-	na	na	na	na						
mental alv foramen	-	-	na	na	na	na						

Table E3. Unpaired infracranial non-metric characteristics.

descriptor						
a. vertebrae	a-25	b-		i-68	s-	v-
atlas facet form	s	na		s		
posterior bridge	-	na		-		
lateral bridge	-	na		-		
transv for bip	2/5	0/1		0/5	0/1	0/1
b. sacrum	a-21		e-5	g-15		
acc sacral facet	-		-	+		

Table E4. Unpaired cranial non-metric characteristics.

descriptor	a-1	c-1	c-2	d-1	e-1	h-2	i-1	i-2	k-1	m-1
metopism	-	-	+	-	-	-	-	-	-	-
bregmatic bone	-	-	-	-	-	-	-	-	-	-
nasal bone shape	G	G	G	G	G	na	G	na	na	na
trans pal suture	ant	sr	pst	ant	sr	na	sr	na	sr	na
palatine torus	+	-	-	-	-	na	+	na	-	na
coronal ossicles	-	-	-	-	-	-	-	-	-	-
high nuchal line	-	+	+	-	-	+	-	+	+	-
ossicle at lambda	-	-	-	-	-	-	-	-	-	-
odont-occip artic	-	na	-	-	-	na	-	-	-	na
pharyngeal fossa	-	na	-	-	-	na	-	-	-	na
sup sagitt sulcus	r	lt	lt	r	r	r	r	r	r	r

Table E4. Continued.

descriptor	0-6	v-44	v-45	v-42	v-68	x-15	x-14	z-1	aa-1
metopism	-	-	-	na	-	-	-	-	-
bregmatic bone	-	-	-	na	-	-	-	-	-
nasal bone shape	G	na	na	G	na	na	na	na	G
trans pal suture	na	na	pst	sr	na	na	na	sr	sr
palatine torus	-	na	-	-	na	na	na	-	+
coronal ossicles	-	-	-	na	na	-	-	-	-
high nuchal line	-	-	+	-	na	-	-	+	+
ossicle at lambda	-	-	-	-	na	-	-	-	-
odont-occip artic	na	na	-	-	na	na	-	na	-
pharyngeal fossa	na	na	+	-	na	na	-	na	-
sup sagitt sulcus	r	r	r	r	r	r	r	r	r

APPENDIX F

Metric and Non-Metric Descriptors of the
Permanent and Deciduous Dentition

Scoring Key

+ = present
- = absent
na = not available
0-3 = levels of expression (0=no expression, 1=mild expression, 2=moderate expression, 3=maximum expression)
d = discontinuous
c = continuous
p = pit
t = tubercle
ts = tuberculum sextum
* = excessive levels of occlusal attrition

Table F1. Paired Metric Dimensions of the Permanent Dentition.

Tooth/Descriptor		a-4		c-1		c-2		d-1		e-1		f-1	
		l	r	l	r	l	r	l	r	l	r	l	r
mandibular													
I_1	length	4.0*	4.2*	--	--	4.7*	4.6*	--	--	--	--	--	--
	breadth	5.8*	5.8*	--	--	5.6*	5.6*	--	--	--	--	--	--
I_2	length	5.0*	5.0*	--	--	--	5.0*	--	--	--	--	--	--
	breadth	6.1*	6.3*	--	--	--	6.0*	--	--	--	--	--	--
C	length	6.5*	6.3*	--	--	6.4*	6.6*	--	--	6.0	6.0	--	--
	breadth	7.4*	6.9*	--	--	7.7*	7.4*	--	--	8.3	8.3	--	--
P_3	length	6.7	--	--	--	6.0*	5.9*	--	--	6.6	6.5	--	--
	breadth	7.0	7.0	--	--	7.8*	7.7*	--	--	8.3	8.5	--	--
P_4	length	6.3	6.4	--	--	6.8	6.7	--	--	--	6.5	--	--
	breadth	7.6	7.2	--	--	8.6	8.5	--	--	--	8.8	--	--
M_1	length	10.0	10.0	--	--	10.6*	10.4*	--	--	10.5	11.1	11.9	--
	breadth	10.2	10.2	--	--	10.8*	10.9*	--	--	11.2	11.1	11.6	--
M_2	length	10.0	10.0	--	--	--	--	--	--	10.3	10.5	--	--
	breadth	9.8	9.9	--	--	--	--	--	--	10.7	10.7	--	--
M_3	length	9.8	9.5	--	--	--	--	--	--	--	10.4	--	--
	breadth	9.0	8.7	--	--	--	--	--	--	--	10.5	--	--
maxillary													
I^1	length	--	7.5*	--	--	--	--	--	--	--	--	--	--
	breadth	--	7.1*	--	--	--	--	--	--	--	--	--	--
I^2	length	--	6.1*	--	--	--	--	--	--	--	--	--	6.9
	breadth	--	6.5*	--	--	--	--	--	--	--	--	--	7.8
C	length	--	7.3*	6.1*	--	6.6*	6.6*	--	--	--	--	--	7.6
	breadth	--	7.7*	--	--	7.6*	7.7*	7.8	--	--	--	--	7.2
P^3	length	--	6.3*	--	--	--	--	--	--	--	--	--	--
	breadth	--	8.9*	--	--	--	--	--	--	--	--	--	--
P^4	length	--	--	5.9*	5.7*	--	--	5.8	--	6.0	--	--	--
	breadth	--	--	10.1*	10.0*	--	--	7.8	--	9.8	--	--	--
M^1	length	9.2*	8.7*	9.0*	9.4*	9.2*	--	9.4	--	--	--	11.1	11.2
	breadth	11.4*	11.2*	12.5*	12.4*	11.3*	--	--	--	--	--	11.6	12.3

Table F1. Continued.

Tooth/Descriptor		a-4 l	a-4 r	c-1 l	c-1 r	c-2 l	c-2 r	d-1 l	d-1 r	e-1 l	e-1 r	f-1 l	f-1 r
M^2	length	--	8.9*	9.5*	10.0*	--	--	8.8	--	9.1	--	--	--
	breadth	--	10.7*	12.5*	12.1*	10.9*	--	--	--	11.9	--	--	--
M^3	length	--	--	9.7*	8.9*	--	--	8.2	8.9	8.7	--	--	--
	breadth	--	--	11.3*	11.3*	10.4*	--	10.8	10.0	10.3	--	--	--

Table F1. Continued.

Tooth/Descriptor		h-2		i-6		j-1		k-1		o-6		p-50	
		l	r	l	r	l	r	l	r	l	r	l	r
mandibular													
I_1	length	--	--	--	--	--	--	--	--	6.4*	6.4*	5.4	5.5
	breadth	--	--	--	--	--	--	--	--	6.3*	6.1*	5.4	5.3
I_2	length	--	5.6	--	--	--	--	--	--	5.4*	5.2*	5.3	5.8
	breadth	--	6.4	--	--	--	--	--	--	5.7*	5.8*	6.3	6.4
C	length	6.8	6.6	--	--	--	--	--	--	8.8	--	--	7.1
	breadth	8.5	8.4	--	--	--	--	--	--	8.6	8.6	--	7.3
P_3	length	7.0	6.9	--	--	--	7.5	--	--	7.1	7.0	--	--
	breadth	8.5	8.2	--	--	--	--	--	--	7.5	7.7	--	--
P_4	length	7.0	7.0	--	--	--	--	--	--	7.6	7.5	--	--
	breadth	8.6	8.6	--	--	--	--	--	--	8.4	8.1	--	--
M_1	length	11.3	--	--	11.6	12.6	--	--	--	--	11.2	12.3	12.4
	breadth	11.1	--	--	10.5	10.7	--	--	--	--	10.7	11.0	10.9
M_2	length	10.8	11.2	--	--	13.3	--	--	--	11.5	--	--	--
	breadth	10.7	10.8	--	--	11.0	--	--	--	10.2	--	--	--
M_3	length	10.4	10.6	--	--	--	--	--	--	--	--	--	--
	breadth	10.7	10.5	--	--	--	--	--	--	--	--	--	--
maxillary													
I^1	length	8.1	8.3	--	--	--	8.9	--	--	--	8.8	9.0	9.4
	breadth	7.2	8.0	--	--	--	7.0	--	--	--	6.9	7.2	7.0
I^2	length	7.3	6.7	--	--	7.5	--	--	--	7.5	7.3	7.5	7.8
	breadth	6.8	6.8	--	--	6.4	--	--	--	6.6	6.6	6.5	6.2
C	length	7.8	7.6	--	--	--	8.4	--	--	7.3	7.1	--	8.8
	breadth	9.8	9.4	--	--	--	--	--	--	7.3	7.4	--	8.3
P^3	length	6.5	6.9	--	--	9.6	9.4	--	7.2	7.5	7.4	--	--
	breadth	10.4	10.6	--	--	7.2	7.9	--	9.2	9.7	9.5	--	--
P^4	length	5.9	6.3	--	--	9.2	9.2	6.9	7.0	--	7.3	--	--
	breadth	10.0	10.0	--	--	7.1	7.0	8.2	--	--	9.8	--	--
M^1	length	10.5	9.5	--	--	11.4	11.0	9.9	10.7	--	--	11.3	11.2
	breadth	12.1	12.6	--	--	11.8	12.0	12.1	11.9	11.1	--	11.9	11.7

Table F1. Continued.

Tooth/Descriptor		h-2		i-6		j-1		k-1		o-6		p-50	
		l	r	l	r	l	r	l	r	l	r	l	r
M^2	length	10.4	10.4	--	--	--	--	--	9.5	10.0	--	--	--
	breadth	11.3	12.5	--	--	--	--	11.8	11.6	11.6	11.7	--	--
M^3	length	--	8.5	--	--	--	--	--	--	--	--	--	--
	breadth	--	10.6	--	--	--	--	--	--	--	--	--	--

Table F1. Continued.

Tooth/Descriptor		t-		v-45		y-		aa-1	
		l	r	l	r	l	r	l	r
mandibular									
I_1	length	--	--	--	--	--	--	--	--
	breadth	--	--	--	--	--	--	--	--
I_2	length	--	--	--	--	--	--	6.6	6.7
	breadth	--	--	--	--	--	--	6.8	7.1
C	length	--	--	--	--	--	--	--	8.1
	breadth	--	--	--	--	--	--	--	8.6
P_3	length	--	--	--	--	--	--	6.5	6.8
	breadth	--	--	--	--	--	--	9.4	9.3
P_4	length	--	--	--	--	--	--	6.6	6.8
	breadth	--	--	--	--	--	--	9.5	9.5
M_1	length	--	--	--	--	--	--	10.9	10.4
	breadth	--	--	--	--	--	--	11.0	11.5
M_2	length	11.8	--	--	--	--	--	10.3	10.2
	breadth	12.0	--	--	--	--	--	11.2	11.7
M_3	length	--	--	--	--	10.4	--	9.8	9.8
	breadth	--	--	--	--	9.7	--	11.5	11.5
maxillary									
I^1	length	--	--	--	--	--	--	--	--
	breadth	--	--	--	--	--	--	--	--
I^2	length	--	--	--	--	--	--	--	--
	breadth	--	--	--	--	--	--	--	--
C	length	--	--	8.3	8.4	--	--	--	--
	breadth	--	--	8.5	8.6	--	--	--	--
P^3	length	--	--	8.1	8.7	--	--	--	--
	breadth	--	--	--	--	--	--	--	--
P^4	length	--	--	--	--	--	--	--	--
	breadth	--	--	--	--	--	--	--	--
M^1	length	--	--	--	--	--	--	--	--
	breadth	--	--	--	--	--	--	--	--

Table F1. Continued.

Tooth/Descriptor		t- l	t- r	v-45 l	v-45 r	y- l	y- r	aa-1 l	aa-1 r
M^2	length	--	9.2	--	10.2	8.7	--	--	--
	breadth	--	12.0	--	11.5	11.4	--	--	--
M^3	length	--	--	9.9	9.2	8.7	8.9	--	--
	breadth	--	--	12.0	11.5	10.2	9.9	--	--

Table F2. Metric dimensions of the deciduous dentition.

Tooth/Descriptor		f- l	f- r	D- l	D- r	V- l	V- r
mandibular							
di_1	length	--	--	--	--	--	--
	breadth	--	--	--	--	--	--
di_2	length	--	--	--	--	--	--
	breadth	--	--	--	--	--	--
dc	length	--	--	6.2	6.1	--	--
	breadth	--	--	5.0	5.1	--	--
dm_1	length	8.4	--	8.0	8.0	--	--
	breadth	6.9	--	7.0	7.1	--	--
dm_2	length	10.6	--	10.5	10.7	--	--
	breadth	9.5	--	9.4	9.3	--	--
maxillary							
di^1	length	--	--	6.8*	--	--	6.1
	breadth	--	--	4.7*	--	--	4.8
di^2	length	--	--	--	--	--	--
	breadth	--	--	--	--	--	--
dc	length	--	--	7.3	7.2	6.9	--
	breadth	--	--	5.5	5.5	5.3	--
dm^1	length	6.8	6.3	7.2*	7.2*	--	7.7
	breadth	8.4	8.4	9.3*	9.2*	--	8.9
dm^2	length	10.0	9.6	9.6	9.7	--	--
	breadth	10.5	10.5	10.6	10.7	--	--

Table F3. Non-metric traits of the permanent dentition.

	a-		f-		j-		k-		o-		p-	
Tooth/Descriptor	l	r	l	r	l	r	l	r	l	r	l	r
I^1 ling marg ridges						2			2	2	1	2
ling marg groove						0			0	0	1	0
cingulum						0			1	1	1	1
I^2 ling marg ridges	na	na		3	2				2	2	1	1
ling marg groove	na	na		0	1				1	0	0	1
cingulum	2	2		1	1				1	1	0	0
C ling marg ridges				2					1	1		1
ling median ridge				1					0	0		0
cingulum				1					1	1		1
P^4 dist transv ridge					-	-				+		
M^1 protoconal complex	na	na	p(1)	t(1)	-	-	-	-			-	t(1)
postprotocrista	na	na	c	d	c	c	na	na			d	d
hypocone	+	+	+	+	+	+	+	+			+	+
buccal pit	2	1	-	1	-	-	-	-			-	-
M^2 protoconal complex	-	-	na	na			na	-	-	-		
postprotocrista	-	-	d	d			na	d	c	c		
hypocone	-	-	+	+			+	+	+	+		
buccal pit	-	-	na	na			-	-	-	-		
M^3 protoconal complex	-								-	-		
postprotocrista	na								d	d		
hypocone	-								-	-		
buccal pit	-								-	-		
I_1 ling marg ridges									1	1	0	0
I_2 ling marg ridges									1	1	1	1
C ling marg ridges									1	1		2
ling median ridge									0	0		0

Table F3. Continued.

Tooth/Descriptor	a- l	a- r	f- l	f- r	j- l	j- r	k- l	k- r	o- l	o- r	p- l	p- r
P_3 protocristid						c			c	c		
lingual groove						-			-	+		
lingual cusps						2			1	1		
P_4 protocristid									c	c		
lingual cusps									1	2		
M_1 cusp number	5	5	5,ts		5						5	5
buccal pit	-	-	-		2						0	1
protostylid	na	na	1		-						-	-
M_2 cusp number	4	4			5,ts				5,ts			
buccal pit	1	1			1				2			
protostylid	-	-			1				-			
M_3 cusp number	4	4										
buccal pit	-	1										
protostylid	-	-										

Table F3. Continued

Tooth/Descriptor		t-		v-45		aa-	
		l	r	l	r	l	r
I^1	ling marg ridges						
	ling marg groove						
	cingulum						
I^2	ling marg ridges					2	2
	ling marg groove					0	0
	cingulum					2	2
C	ling marg ridges			2	2	0	
	ling median ridge			1	1	0	
	cingulum			1	1	1	
P^4	dist transv ridge					-	-
M^1	protoconal complex					p(1)	-
	postprotocrista					c	c
	hypocone					+	+
	buccal pit					1	1
M^2	protoconal complex		na			-	-
	postprotocrista		na			c	c
	hypocone		-			+	+
	buccal pit		-			1	1
M^3	protoconal complex			na	na	-	-
	postprotocrista			c	c	d	d
	hypocone			+	+	-	-
	buccal pit			na	na	-	1
I_1	ling marg ridges						
I_2	ling marg ridges						
C	ling marg ridges						
	ling median ridge						

Table F3. Continued

	t-		v-45		aa-	
Tooth/Descriptor	l	r	l	r	l	r
P_3 protocristid						
lingual groove						
lingual cusps						
P_4 protocristid						
lingual cusps						
M_1 cusp number						
buccal pit						
protostylid						
M_2 cusp number	5					
buccal pit	1					
protostylid	-					
M_3 cusp number						
buccal pit						
protostylid						

Table F4. Non-metric traits of the deciduous dentition.

Tooth/Descriptor		f–		p–		v–	
		l	r	l	r	l	r
di^1	marginal ridges						1
di^2	marginal ridges						
dc	marginal ridges					2	
	lingual styles					1	
dm^1	cusp number						3
	ecostyle-j						–
	mesiostyle						–
dm^2	cusp number	4	4	4	4		
	entostyle-g	–	–	na	na		
	ecostyle-j	–	–	na	na		
	anterior crista	na	na	na	na		
	plagiocrista	na	na	c	c		
di_1	marginal ridges						
di_2	marginal ridges						
dm_1	cusp number						
	postentoconulid						
	split distostylid						
dm_2	cusp number			5	5		
	postmetaconulid			na	na		
	postentoconulid			na	na		

APPENDIX G

List of Radiographs

Table G1. Inventory of radiographs.

element	exposure	setting
cranium (a-4)	antero-posterior	3mas, 77kv
	left lateral	3mas, 70kv
cranium (c-1)	antero-posterior	3mas, 77kv
	left lateral	3mas, 70kv
cranium (c-2)	antero-posterior	3mas, 77kv
	left lateral	3mas, 70kv
cranium (d-1)	antero-posterior	3mas, 77kv
	left lateral	3mas, 70kv
cranium (e-1)	antero-posterior	3mas, 77kv
	left lateral	3mas, 70kv
cranium (f-1)	antero-posterior	3mas, 77kv
	left lateral	3mas, 70kv
cranium (i-1)	antero-posterior	3mas, 77kv
	left lateral	3mas, 70kv
cranium (i-2)	antero-posterior	3mas, 77kv
	left lateral	3mas, 70kv
cranium (k-1)	antero-posterior	3mas, 77kv
	left lateral	3mas, 70kv
cranium (x-14)	antero-posterior	3mas, 77kv
	left lateral	3mas, 70kv
cranium (x-15)	antero-posterior	3mas, 77kv
	left lateral	3mas, 70kv
cranium (aa-1)	antero-posterior	3mas, 77kv
	left lateral	3mas, 70kv
tibiae (b-55, i-50, m-10 n-8)	antero-posterior	5mas, 60kv

Table G1. Continued.

element	exposure	setting
diaphyses (i-150,i-154, n-1, n-3, n-9, n-10, p-3, p-5, p-6)	antero-posterior	5mas, 56kv
right radius (v-16)	antero-posterior	5mas, 60kv
second lumbar vertebra (s-53)	medial-lateral	5mas, 60kv
fourth and fifth lumbar vertebrae (g-48, g-49)	superior-inferior	5mas, 60kv

APPENDIX H

Analysis Of Trace Minerals

Phyllis Johnson
United States Department of Agriculture
Human Nutrition Research Laboratory
Grand Fork, North Dakota

Bone samples were first crushed to reduce the bone to macroscopically large fragments. This took place inside plastic bags to retain the bone fragments. The samples were then ground with a mortar and pestle into a fine powder. Duplicate one gram samples were weighed into Erlenmeyer flasks. Five ml of concentrated nitric acid (Baker Instraanalyzed, trace mineral grade) were added, and the flasks covered and allowed to set for 24 hr. The flasks were then heated on hot plates and boiled slowly for 6-8 hr. After boiling to dryness, 5 ml of concentrated nitric acid were again added and the samples allowed to set overnight. The next day they were heated as before until nearly all the nitric acid had evaporated. Then 3 ml nitric acid and 10 ml hydrogen peroxide (30%) were added. Samples were again heated and boiled to dryness. Samples were resuspended in 1 ml 6 N hydrochloric acid and transferred quantitatively to 10 ml volumetric flasks. Samples were brought to volume with demineralized water. Blanks (no sample) and bovine liver standards (NBS certified) were treated in the same manner.

Some samples contained a fine white precipitate at the end of the wet-ash procedure. This precipitate was insoluble in nitric acid or hydrochloric acid. Samples were centrifuged to separate the precipitate before analysis. The precipitate was found to be easily soluble in hydrofluoric acid, which indicated that it was probably silicates. All other minerals of interest would be soluble in the nitric and hydrochloric acid.

Samples were analyzed for trace mineral content using inductively coupled argon plasma emission spectrophotometry.

APPENDIX I

STABLE ISOTOPE ANALYSIS
REPORT FORM

KRUEGER ENTERPRISES, INC.
GEOCHRON LABORATORIES DIVISION
24 BLACKSTONE STREET • CAMBRIDGE, MASSACHUSETTS 02139 • (617) 876-3691

STABLE ISOTOPE RATIO ANALYSES — REPORT OF ANALYTICAL WORK

Submitted by: Dr. John A. Williams
Dept. of Anthropology
Univ. of North Dakota
Box 8254, Univ. Station
Grand Forks, ND 58202

Date Received: 06/18/87
Date Reported: 11/20/87
Your Reference: letter of 06/16/87 PO#221533

Our Lab. Number	Your Sample Number		Description	Analysis* $^{13}C_{gelatin}$	$^{15}N_{gelatin}$
NCR-46146	2	39CO34	Bone gelatin	- 12.2	+ 10.1
NCR-46147	3	39CA4	"	- 13.7	+ 9.7
NCR-46148	4	39CA4	"	- 12.7	+ 9.4
NCR-46149	5	39HU203	"	- 12.5	+ 8.8
NCR-46150	6	39LM59	"	- 13.5	+ 9.2
NCR-46151	7	39LM57	"	- 11.9	+ 8.9
NCR-46152	8A	39LM256	"	- 16.4	+ 10.0
NCR-46153	8B	39LM256	"	- 17.7	+ 9.6
NCR-46154	9	39ST235	"	- 11.2	+ 8.5

Note: These ^{13}C analyses are by the closed tube combustion method and are probably more reliable than the values previously reported with the radiocarbon age determinations.

*Unless otherwise noted, analyses are reported in ‰ notation and are computed as follows:

$$\delta R_{sample} ‰ = \left[\frac{R_{sample}}{R_{standard}} - 1 \right] \times 1000$$

Where:

D/H	standard is SMOW
$^{13}C/^{12}C$	standard is PDB
$^{15}N/^{14}N$	is Atmospheric Nitrogen
$^{18}O/^{16}O$	standard is SMOW
$^{34}S/^{32}S$	standard is Cañon Diablo troilite

And:

$D/H_{standard}$	= 0.000316**
$^{13}C/^{12}C_{standard}$	= 0.011237
$^{15}N/^{14}N_{standard}$	= 0.007353**
$^{18}O/^{16}O_{standard}$	= 0.0039948**
$^{34}S/^{32}S_{standard}$	= 0.0450045

**Double atom ratio

APPENDIX J

Radiocarbon Age Determination Reporting Forms

KRUEGER ENTERPRISES, INC.
GEOCHRON LABORATORIES DIVISION
24 BLACKSTONE STREET • CAMBRIDGE, MASSACHUSETTS 02139 • (617) 876-3691

RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No. GX- 13398 — Date Received: 06-18-87

Your Reference: Letter of 06-16-87. — Date Reported: 10-12-87

Submitted by: John A. Williams
Dept. of Anthropology
University of North Dakota
Box 8254, University Station
Grand Forks, ND 58202

Sample Name: Sample #1. Site 39LM59.

AGE = 1135 +/- 95 C-14 Years B.P. (C-13 corrected).

Description: Sample of charcoal.

Pretreatment: The charcoal fragments were separated from any sand, silt, rootlets, or other foreign matter. The sample was then treated with hot dilute HCl and with hot dilute NaOH to remove carbonates and organic contaminants. After washing and drying, the charcoal was then combusted to carbon dioxide for the analysis.

Comment:

$\delta^{13}C_{PDB} = -26.5$ ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION		REPORT OF ANALYTICAL WORK	
Our Sample No.	GX- 13399	Date Received:	06-18-87
Your Reference:	Letter of 06-16-87.	Date Reported:	10-12-87

Submitted by: John A. Williams
Dept. of Anthropology
University of North Dakota
Box 8254, University Station
Grand Forks, ND 58202

Sample Name: Sample #2. Site 39CO34.

AGE = 950 +/- 75 C-14 Years B.P. (C-13 corrected).

Description: Sample of human bone.

Pretreatment: The insoluble residue from the bone apatite dissolution procedure was filtered and washed. It was then boiled in slightly acid dist. water to solubilize the collagen. This broth was filtered and the filtrate was evaporated to dryness to recover the collagen as bone gelatin. Rootlets and humic acids would have been removed by the filter. The recovered bone gelatin was combusted and the carbon dioxide was collected and analyzed

Comment:

$\delta^{13}C_{PDB} = -12.4$ ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.
The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No.	GX- 13400	Date Received:	06-18-87
Your Reference:	Letter of 06-16-87.	Date Reported:	10-12-87

Submitted by: John A. Williams
Dept. of Anthropology
University of North Dakota
Box 8254, University Station
Grand Forks, ND 58202

Sample Name: Sample #3. Site 39CA4.

AGE = 555 +/- 75 C-14 Years B.P. (C-13 corrected).

Description: Sample of human bone.

Pretreatment: The insoluble residue from the bone apatite dissolution procedure was filtered and washed. It was then boiled in slightly acid dist. water to solubilize the collagen. This broth was filtered and the filtrate was evaporated to dryness to recover the collagen as bone gelatin. Rootlets and humic acids would have been removed by the filter. The recovered bone gelatin was combusted and the carbon dioxide was collected and analyzed

Comment:

$\delta^{13}C_{PDB}$ = -12.9 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No.	GX- 13401	Date Received:	06-18-87
Your Reference:	Letter of 06-16-87.	Date Reported:	10-12-87

Submitted by: John A. Williams
Dept. of Anthropology
University of North Dakota
Box 8254, University Station
Grand Forks, ND 58202

Sample Name: Sample #4. Site 39CA4.

AGE = 540 +/- 75 C-14 Years B.P. (C-13 corrected).

Description: Sample of human bone.

Pretreatment: The insoluble residue from the bone apatite dissolution procedure was filtered and washed. It was then boiled in slightly acid dist. water to solubilize the collagen. This broth was filtered and the filtrate was evaporated to dryness to recover the collagen as bone gelatin. Rootlets and humic acids would have been removed by the filter. The recovered bone gelatin was combusted and the carbon dioxide was collected and analyzed

Comment:

$\delta^{13}C_{PDB}$ = -11.8 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.
The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION | REPORT OF ANALYTICAL WORK

Our Sample No.	GX- 13402	Date Received:	06-18-87
Your Reference:	Letter of 06-16-87.	Date Reported:	10-12-87

Submitted by: John A. Williams
Dept. of Anthropology
University of North Dakota
Box 8254, University Station
Grand Forks, ND 58202

Sample Name: Sample #5. Site 39HU203.

AGE = 1260 +/- 75 C-14 Years B.P. (C-13 corrected).

Description: Sample of human bone.

Pretreatment: The insoluble residue from the bone apatite dissolution procedure was filtered and washed. It was then boiled in slightly acid dist. water to solubilize the collagen. This broth was filtered and the filtrate was evaporated to dryness to recover the collagen as bone gelatin. Rootlets and humic acids would have been removed by the filter. The recovered bone gelatin was combusted and the carbon dioxide was collected and analyzed

Comment:

$\delta^{13}C_{PDB}$ = -11.0 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION | **REPORT OF ANALYTICAL WORK**

Our Sample No.	GX- 13403	Date Received:	06-18-87
Your Reference:	Letter of 06-16-87.	Date Reported:	10-12-87

Submitted by: John A. Williams
Dept. of Anthropology
University of North Dakota
Box 8254, University Station
Grand Forks, ND 58202

Sample Name: Sample #6. Site 39LM59.

AGE = 1170 +/- 75 C-14 Years B.P. (C-13 corrected).

Description: Sample of human bone.

Pretreatment: The insoluble residue from the bone apatite dissolution procedure was filtered and washed. It was then boiled in slightly acid dist. water to solubilize the collagen. This broth was filtered and the filtrate was evaporated to dryness to recover the collagen as bone gelatin. Rootlets and humic acids would have been removed by the filter. The recovered bone gelatin was combusted and the carbon dioxide was collected and analyzed

Comment:

$\delta^{13}C_{PDB}$ = -11.1 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION — REPORT OF ANALYTICAL WORK

Our Sample No.	GX- 13404	Date Received:	06-18-87
Your Reference:	Letter of 06-16-87.	Date Reported:	10-12-87

Submitted by: John A. Williams
Dept. of Anthropology
University of North Dakota
Box 8254, University Station
Grand Forks, ND 58202

Sample Name: Sample #7. Site 39LM57.

AGE = 1080 +/- 75 C-14 Years B.P. (C-13 corrected).

Description: Sample of human bone.

Pretreatment: The insoluble residue from the bone apatite dissolution procedure was filtered and washed. It was then boiled in slightly acid dist. water to solubilize the collagen. This broth was filtered and the filtrate was evaporated to dryness to recover the collagen as bone gelatin. Rootlets and humic acids would have been removed by the filter. The recovered bone gelatin was combusted and the carbon dioxide was collected and analyzed

Comment:

$\delta^{13}C_{PDB}$ = -11.7 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.
The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION | REPORT OF ANALYTICAL WORK

Our Sample No.	GX- 13405 -1	Date Received:	06-18-87
Your Reference:	Letter of 06-16-87.	Date Reported:	10-12-87

Submitted by: John A. Williams
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Box 8254, University Station
Grand Forks, ND 58202

Sample Name: Sample #8. Site 39LM256.
Sample contained two left femurs. We dated these separatley and are reporting them as GX-13405-1 and GX-13405-2.

AGE = 1725 +/- 120 C-14 Years B.P. (C-13 corrected).

Description: Sample of human bone.

Pretreatment: The insoluble residue from the bone apatite dissolution procedure was filtered and washed. It was then boiled in slightly acid dist. water to solubilize the collagen. This broth was filtered and the filtrate was evaporated to dryness to recover the collagen as bone gelatin. Rootlets and humic acids would have been removed by the filter. The recovered bone gelatin was combusted and the carbon dioxide was collected and analyzed

Comment:

$\delta^{13}C_{PDB}$ = -16.0 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid.
The age is referenced to the year A.D. 1950.

KRUEGER ENTERPRISES, INC.
GEOCHRON LABORATORIES DIVISION
24 BLACKSTONE STREET • CAMBRIDGE, MASSACHUSETTS 02139 • (617) 876-3691

RADIOCARBON AGE DETERMINATION | **REPORT OF ANALYTICAL WORK**

Our Sample No.	GX- 13405 -2	Date Received:	06-18-87
Your Reference:	Letter of 06-16-87.	Date Reported:	10-12-87

Submitted by: John A. Williams
Dept. of Anthropology
University of North Dakota
Box 8254, University Station
Grand Forks, ND 58202

Sample Name: Sample #8. Site 39LM256.
Sample contained two left femurs. We dated these separatley and are reporting them as GX-13405-1 and GX-13405-2.

AGE = 1620 +/- 80 C-14 Years B.P. (C-13 corrected).

Description: Sample of human bone.

Pretreatment: The insoluble residue from the bone apatite dissolution procedure was filtered and washed. It was then boiled in slightly acid dist. water to solubilize the collagen. This broth was filtered and the filtrate was evaporated to dryness to recover the collagen as bone gelatin. Rootlets and humic acids would have been removed by the filter. The recovered bone gelatin was combusted and the carbon dioxide was collected and analyzed

Comment:

$\delta^{13}C_{PDB} = -16.5$ ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

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RADIOCARBON AGE DETERMINATION **REPORT OF ANALYTICAL WORK**

Our Sample No.	GX- 13406	Date Received:	06-18-87
Your Reference:	Letter of 06-16-87.	Date Reported:	10-12-87

Submitted by: John A. Williams
Dept. of Anthropology
University of North Dakota
Box 8254, University Station
Grand Forks, ND 58202

Sample Name: Sample #9. Site 39ST235.

AGE = 295 +/- 75 C-14 Years B.P. (C-13 corrected).

Description: Sample of human bone.

Pretreatment: The insoluble residue from the bone apatite dissolution procedure was filtered and washed. It was then boiled in slightly acid dist. water to solubilize the collagen. This broth was filtered and the filtrate was evaporated to dryness to recover the collagen as bone gelatin. Rootlets and humic acids would have been removed by the filter. The recovered bone gelatin was combusted and the carbon dioxide was collected and analyzed

Comment:

$\delta^{13}C_{PDB}$ = -11.0 ‰

Notes: This date is based upon the Libby half life (5570 years) for ^{14}C. The error stated is $\pm 1\sigma$ as judged by the analytical data alone. Our modern standard is 95% of the activity of N.B.S. Oxalic Acid. The age is referenced to the year A.D. 1950.

December 2, 1987

Dr. John A. Williams
Department of Anthropology
University of North Dakota
Grand Forks, ND
58202

Dear Dr. Williams,

Your bone sample has been dated with the following result:

SMU 1945, collagen fraction	
fractionation corrected age	1170 ± 60 BP
δC13/12	-17.7 ‰
calibrated age	860 ± 80 AD

For the purpose of inclusion of this date in a future Radiocarbon date list we need information on the provenience of the sample. Please return the enclosed form at your earliest convenience.

Sincerely,

Herbert Haas

Dr. Herbert Haas
Director

enclosure: copy of invoice sent to purchasing department of University of North Dakota.

HH/mnm

RADIOCARBON LABORATORY
INSTITUTE FOR THE STUDY OF EARTH AND MAN / 214 · 692-3429
SOUTHERN METHODIST UNIVERSITY / DALLAS, TEXAS 75275

APPENDIX K

RECOMMENDATIONS FOR TRACE MINERAL SOIL SAMPLES

No standards currently exist for the retrieval of burial matrix in trace element analysis. The procedure described below is one option that may provide for the control of diagenetic factors of the immediate burial matrix soil (Della Cook and Arthur Aufderheide, personal communication, 1988):

1) prior to excavation and removal of burial matrix, identify the bone(s) to be tested for trace element content (preferably a dense long bone such as the femur or tibia)
2) using a plastic tool (to avoid iron or other metal contamination) remove soil matrix from the area around the bone in a manner so as to create a circular "halo"
3) the soil matrix should be removed from three concentric rings or "halos" of approximately 0.5 cm in thickness for a total 500 grams in weight per "halo" sample
4) each .5 cm ring should be placed in a commercially manufactured plastic soil sample bag

This procedure may be difficult to implement under "salvage" conditions as it requires a prior commitment to trace element analysis and the tools and supplies necessary for the proper removal of uncontaminated soil samples.